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FISH POPULATION SAMPLING STUDIES AT WATER POLLUTION SURVEILLANCE SYSTEM STATIONS ON THE OHIO, TENNESSEE, CLINCH AND CUMBERLAND RIVERS

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Exploratory studies to evaluate collecting equipment and to determine the best methods for obtaining representative fish population samples at Water Pollution Surveillance System stations on large rivers are reported. Use of rotenone and electric shocker is recommended as most efficient. Data collected were used to evaluate the fish population in terms of species present, relative abundance, and size distribution.

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FOREWORD

Fish population studies have been undertaken to provide an additional measure of pollution at Water Pollution Surveillance System stations.

Biological data obtained from fish population studies, benthos studies and plankton studies can tell much about the responses of living organisms to their total environment of which water quality is an important part. The physical, chemical, and biological data collected for the Surveillance System affords unusual opportunities to compare biological populations with water quality characteristics. Through periodic long term sampling of the water and fish populations it is possible to assemble data that can be used to characterize and demonstrate the effect of various pollutants.

The fish studies reported here are primarily exploratory to evaluate collecting gear and to determine the best methods required to obtain representative fish population samples at Water Pollution Surveillance System stations on large rivers. Stations on the Ohio, Tennessee, Clinch, and Cumberland Rivers were selected as representing a variety of habitat.

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SUMMARY

In cooperation with the Alabama Department of Fish and Game; Tennessee Game and Fish Commission; Fish and Game Branch, Tennessee Valley Authority; Kentucky Department of Fish and Wildlife Resources and the West Virginia Department of Natural Resources, the fish population at ten Water Pollution Surveillance System stations on the Ohio, Tennessee and Cumberland Rivers (Figures 1 and 2) were sampled during the summer of 1963. Rotenone samples could not have been obtained without the manpower and equipment furnished by the above agencies.

Sampling was conducted using a variety of methods including rotenone, electric shocker, seines and trammel nets. Except in special circumstances, seines and trammel nets were very inefficient for obtaining a representative sample of fish from the large rivers studied, and they duplicated the data obtained by the much more efficient and less selective samples obtained with rotenone and electric shocker. It is recommended that rotenone and electric shocker be utilized for sampling the fish population at all Water Pollution Surveillance System stations where fishery studies are conducted. Sampling with the electric shocker requires a crew of three men and one boat while with rotenone a minimum of six men and three boats are necessary to conduct a sampling operation.

Data collected with the electric shocker and rotenone were used to evaluate the fish populations in terms of species present, their relative abundance and their size distribution. An additional parameter which is amenable to quantitative comparison, namely, catch-per-unit-effort, should be obtained in future studies with the electric shocker.

The Clinch and Tennessee Rivers were sampled in the vicinity of Water Pollution Surveillance stations located at Clinton, Tennessee; Kingston, Tennessee; Lenoir City, Tennessee; Chattanooga, Tennessee; and Bridgeport, Alabama. The diversity and quality of the fish populations at the above stations varied considerably. These differences appeared to be a result of differences in the type of habitat sampled, particularly in relation to the effect of impoundment on the habitat. With the possible exception of the Chattanooga station, there were no population differences attributable to pollution. High population levels and an abundance of scavenger species (carp and buffalo) at Chattanooga may show the effects of enrichment from the city of Chattanooga, and particularly from the tanneries located along the river in the vicinity of the area sampled.

The Ohio River was sampled at Water Pollution Surveillance stations located at Huntington, West Virginia; Cincinnati, Ohio; Louisville, Kentucky; and Evansville, Indiana. The Ohio River fish population is characterized by an unusually abundant minnow population with emerald

shiners comprising from 53.8 to 87.8 per cent of the total number of specimens collected with the electric shocker. All stations sampled had an excellent population of desirable game and food species and a diverse population of forage species composed of both plankton and insect feeders. Few adult specimens were collected at the Huntington station and almost the entire collection was composed of young-of-the year fish. The incidence of disease and parasitism was high at Huntington and a few diseased and parasitized fish were collected at Cincinnati. Parasitized and diseased fish were not noted at Louisville and Evansville.

The Cumberland River station sampled had a diverse fish population similar to that found in the Ohio River. Redhorse, a group of fish requiring a clean bottom and relatively intolerant of pollution, were abundant in the area sampled.

WATER POLLUTION SURVEILLANCE SYSTEM FISH STUDIES

INTRODUCTION

Fish require water relatively high in dissolved oxygen and are intolerant of many chemical and physical contaminants resulting from agricultural, industrial, and mining practices. However, the tolerence of different species varies, and man-induced changes of the environment often result in conditions affecting one species more than another, producing imbalanced populations which quite often favor less economically desirable species. It is this variability in response which makes fish usable indicators of environmental disturbance.

Moderate amounts of putrescible wastes may enrich the habitat, resulting in great increases in standing crops of fish present. However, under such conditions the more tolerant and adaptable species may comprise a disproportionate share of the total population (Tebo, 1959), and very sensitive species may be eliminated altogether (Katz and Gaufin, 1953). The effect of toxic wastes may vary from complete elimination of populations to a reduction in reproductive capacity, growth, and resistance to disease and parasitism.

Fish kills are a spectacular and obvious indication that an abrupt change has taken place in the environment. However, because of high mobility resulting in rapid recruitment, the fish population in a river or stream may return to normal levels within a very short time after a kill. Therefore, the presence of an abundant and varied population of fish is not in itself an indication that a habitat is healthy, and may give no indication of intermittent pollution resulting from spills.

Chronic pollution, to which the fish population must adjust over a period of time, will be reflected in the kinds and relative abundance of the fish species present. In addition to the species composition, the condition of the fish, their growth, reproductive success, and certainly their palatability are factors which are of considerable importance in evaluating the suitability of a body of water for supporting useable stocks of fish. However, the importance of a measurement of fish populations does not rest solely on their value as a parameter of "water quality".

"Water quality" is an ambiguous term and depends on the frame of reference, that is, what beneficial use we may be considering in relation

to various parameters of water under consideration. For instance, soft water that is suitable for domestic consumption, with copper concentration of one-half to one ppm, may be lethal to fish. Likewise, water having high bacterial counts would not be suitable for domestic consumption, but might support an excellent fish population. Numerous similar conflicts in quality requirements can be found between most of the beneficial uses of water.

Therefore, fish population data, if used as an indicator of "water quality", require careful interpretation. In many cases if a body of water is suitable for fish it will be suitable for many other uses, but this is by no means always true.

As pointed out by Doudoroff and Warren (1957), fish, because they are a beneficial use, can be used as a direct measure of pollution. The maintenance of fish life has been recognized by the Congress, and by states which have protective pollution-control legislation, as an important and legitimate use of our nations waterways. In this respect, fish are unique in that they are the only parameter measured by the Water Pollution Surveillance System which provide a direct measurement of the impact of changing pollutional loads on a beneficial use.

During 1963 the Water Pollution Surveillance System inaugurated a fish-sampling program at selected stations on the Clinch, Tennessee, and Cumberland Rivers in Tennessee and Alabama, and on the Ohio River bordering the states of Ohio, West Virginia, Kentucky and Indiana (Figures 1 and 2). These studies were carried out in cooperation with biologists of the Alabama Department of Fish and Game; Tennessee Game and Fish Commission; Fish and Game Branch, Tennessee Valley Authority; Kentucky Department of Fish and Wildlife Resources; and the West Virginia Department of Natural Resources. The initial studies reported here were exploratory to determine the best types of gear for sampling large rivers, and the type of fish population data that could feasibily be collected at the national system of stations located on major rivers.

Numerous methods have been used for the evaluation of fish populations in relation to pollution. Katz and Gaufin (1953) in a study of a small midwestern stream compared variously polluted zones on the basis of the number of fish species present, relative abundance of different species, presence or absence of sensitive species, and catch-per-unit effort. These authors felt that numbers of species and relative abundance were the most important indicators of pollution.

Patrick (1950) includes fish as one of seven groups of organisms used to evaluate the pollutional status of a stream. The evaluation was based on a comparison of numbers of species at reportedly healthy control stations with the numbers of species at variously polluted stations. This method requires that unpolluted control stations with similar habitat characteristics are available for study. This is unlikely to be true in the major rivers sampled by the Water Pollution Surveillance System.

Tebo (1959) compared variously polluted arms of a warmwater reservoir on the basis of a statistical analysis of catch-per-unit-effort and the relative abundance of the different species present. These methods appeared to provide a sensitive measure of the effects of moderate organic pollution on fish populations, but only on a comparative basis, i.e. for comparing different years at the same station or different stations with a similar control station.

Swingle (1954) utilized the ratios between different components of the population to evaluate the effect of pollution and impoundment on the fish populations of Alabama rivers. In prior small pond work (Swingle, 1950) these ratios were developed to evaluate population "balance" in a restricted habitat containing a single predator (largemouth bass) and a single prey (bluegill)species. Swingle defines a "balanced" population as one capable of producing satisfactory yearly crops of harvestable fish. What a satisfactory yearly crop of fish should be in a large warmwater river containing a complex of food, game, forage, and trash species is not stated. To evaluate "balance", using Swingle's definition, would require a considerable amount of commercial and sport fishery data from many different types of river habitats. These data are simply not presently available. The use of these ratios requires that all segments of the fish population are sampled in proportion to their abundance in the population and that all segments of the habitat are sampled. The first requirement cannot be satisfied in large rivers particularly in regard to important carnivores such as white bass, walleye, and sauger.

In making a decision on which parameters on the fish population were to be measured at Water Pollution Surveillance System stations, several factors were taken into consideration. These included first, the objectives of the Water Pollution Surveillance System, and secondly, the limitations of time and manpower available for sampling fish populations at a nationwide system of stations.

From the standpoint of fisheries an important objective of the Water Pollution Surveillance System is to provide a baseline of data to evaluate the effects of future changes in the pollutional loads carried in our lakes and rivers. With a baseline of data available it will be possible to pinpoint the effects (on fish) of increased degradation resulting from future population and industrial growth. Possibly as important, such data will be useful in evaluating the effectiveness of pollution control measures on the aquatic habitat. The importance of a background of fisheries data for enforcement purposes is obvious, particularly data from streams, rivers, and lakes not presently degraded.

There are a number of parameters relating to the fish population which may reflect the effects of changes in the environment. These include species present, relative and absolute abundance of each species, size distribution, growth, condition, success of reproduction, incidence of disease and parasitism, and palatability.

Species present, relative abundance, condition, size distribution (with a particular gear), a measure of reproductive success, and the incidence of disease and parasitism were parameters selected. These parameters can be measured on a routine basis with standard gear and a minimum of time and effort. It should be pointed out that these parameters, particularly species present and relative abundance, may not be of immediate importance in evaluating the suitability of a habitat, but attain a maximum of value in determining the effects of changes in the habitat over long periods of time.

Absolute abundance, growth, and palatability require considerable amounts of time, equipment, manpower and/or specialized studies, so they were omitted from routine consideration. These parameters may be of more importance for an immediate, or single sample, evaluation of the suitability of a habitat; however, for reasons pointed out above, they were not considered usable for long-term study at a nationwide system of stations.

METHODS

Electric Shocker:

The power source for the shocking gear was a Homelite Model 8A115 gasoline-driven generator with an output rating of 3000 watts, 115 volts AC. The output to the electrodes was controlled by a Model III, Variable Voltage Pulsator (VVP) manufactured by Pikes Peak Electronics. With the VVP the output could be varied from 0-280 volts AC, 0-300 volts DC and 0-300 volts pulsed DC. The pulse frequency could be varied from 10-200 PPS with a duty cycle of from 20% to 80% at all pulse rates. The unit was operated from a 15' 10" Arkansas Traveler boat which acted as the negative electrode. A probe with changeable positive electrodes, similar to that described by Thomas (1963), was used. In place of the pressure switch on the probe as described by Thomas (1963), two foot switches (one for the boat operator and one for the person handling the probe) were used. In use, the shocker was operated with pulsing DC at maximum voltage, and 40 to 50 pulses per second.

Three people were required to conduct the shocking operation. In addition to a boat operator who handled the VVP, there were two men on a platform at the bow of the boat, one of whom handled the positive probe, and the other picked up affected fish in a small mesh dip net.

For night time operations two 150 watt outdoor flood lamps were mounted on the bow of the boat.

The shocker proved effective in capturing a wide range of sizes of fish of many species. The main disadvantage is its ineffectiveness at depths much in excess of four feet. Where there was a shallow, gradually sloping bottom along the shoreline, or the water was clear, fish tended to move out ahead of the boat and were not picked up in the electrical field. However, under these conditions night time shocking proved to be very effective.

There was considerable variation in species composition from shocking conducted during hours of daylight and hours of darkness, as shown by the data from Louisville, Kentucky (Table 1). Forage species, such as gizzard shad and emerald shiner, were abundant in the daytime but moved out after dark when the large predators such as bass and catfish moved inshore. Freshwater drum,carp, buffalo, and catfish were not taken in the clear water at Louisville in the daytime but were fairly abundant along the shoreline at night. One species, the spotfin shiner, was collected only during the day at all of the sampled stations.

Rotenone:

Based on a visual estimate of the area to be sampled five-per cent emulsified rotenone was applied at a rate of 1 ppm (1 gal. per 3 acre foot) with a 5500 GPH Homelite, gasoline-driven pump. Two hoses were attached at the pump outlet, so that the toxicant could be surface sprayed and applied to deep water simultaneously. Two men were required to apply the rotenone, one to operate the boat and the pump, while the other handled the hoses. To obtain uniform and rapid vertical distribution of toxicant the lower ten or twelve feet of one hose was perforated at 10 inch intervalvs and the end was weighted.

In addition to the boat applying the rotenone at least one boat, and preferably more, each with a two-man crew, are required to pick up the affected fish. Fish affected by rotenone struggle at the surface for only a few minutes before dying and sinking. Therefore, to effect an efficient pickup in the short time fish are accessible, it is important to have as large a pickup crew as can be obtained. This is particularly important in river sampling where no second day pickup is possible.

The greatest difficulty in using rotenone in large rivers is locating suitable sites for sampling. Four main types of areas were sampled: (1) blind coves along the river bank, (2) mouths of small tributary streams, (3) channels between islands and river banks, and (4) partial enclosures created by navigational lock walls. In sites with no current, such as coves, mouths of intermittent streams with no flow, and behind lock walls, the mouth of the area was closed off with one-inch mesh block nets.

The application began at the mouth, or open end of the site, and the boat applying toxicant moved back and forth across the area at uniform intervals to obtain an even distribution of the toxicant. In areas of flowing water, such as narrow channels between islands and shore, the rotenone was applied for a period of approximately 30 minutes in a continuous curtain from the upstream end of the area.

Trammel Nets:

Nylon trammel nets forty yards in length with 10-inch outer and 1½-inch inner mesh walls were used at a few stations.

Although effective in taking larger fish the use of trammel nets in river sampling is somewhat limited because of the difficulty of locating suitable sites to anchor the nets. Even where suitable sites are located the nets are often rendered ineffective by trash carried in the current.

Heavy currents in the large rivers sampled make it necessary to orient the nets with the current and parallel to the shoreline. Trees fallen into the river from the shore, pilings, and the downstream end of islands generally serve as suitable sites to anchor nets.

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Seines:

Nylon seines, 100' X 8' X 1", 25' X 6' X ¼", and 10' X 4' X ¼" were used at several stations.

Seining proved to be inefficient for sampling large rivers. The few species taken by the seines were captured readily with the electric shocker. In addition , it was very difficult to locate areas, free of obstructions, which could be sampled with a seine.

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Discussion of Methods:

Inherent in any attempt to obtain a representative sample of fish is the effect of gear selectivity. Gear selectivity is the ability of a gear to collect only certain species and sizes of fish. The two factors affecting this selectivity are: (1) The portion of the habitat sampled by the gear, and (2) The actual efficiency of the gear in capturing different species and sizes of fish present in the portion of the habitat sampled.

Fish are not uniformly distributed either vertically or horizontally in a river. There are benthic species and limnetic (open water) species, and within each of these two major groups are gradations of preference from deep to shallow water and from swift current to the quiet pool and back-water areas. Distribution of a particular species may also vary diurnally and seasonally.

For purposes of this discussion gear can be classified as passive or active. Passive gear includes various types of nets or traps that entangle or entrap fish and depend for their success on the movement of

fish throughout the habitat. Passive gear is very selective for both species and size of fish captured and is relatively inefficient for obtaining representative samples. For survey purposes, although manpower requirements are low, the time involved in obtaining an adequate sample with passive gear may be prohibitive.

Active gear, including seines, trawls, electrical shocking methods and toxicants, is used for capturing fish on site and does not depend on fish movement. Active methods are relatively non-selective and, although manpower requirements are high, they are efficient in obtaining samples in a short time. None of these methods sample all types of habitat in a large river. Toxicants such as rotenone are useful for sampling quiet backwaters or areas where the toxicant can be concentrated over a small area. Electrical shocking methods are only effective in relatively shallow water but can be used in both fast and slow-moving currents. Seines and trawls can only be utilized in areas free of obstructions and the seine is additionally limited to the shallow water, shoreline areas. The use of midwater trawls in large rivers should be investigated.

From the foregoing discussion it is obvious that no one gear can be expected to provide a representative sample of a fish population. For the present studies three types of active gear (electrical shocker, rotenone and seines) and one type of passive gear (trammel net) were used.

Rotenone was very effective where suitable sampling sites were located and sufficient personnel were available. A minimum of six people and three boats are required to obtain an adequate sample. Rotenone, as used in these studies, was relatively ineffective for capturing limnetic and deep-water species such as white bass, walleye, and sauger. Rotenone is probably selective for gizzard and threadfin shad because of their high susceptibility. Rotenone should be utilized for Water Pollution Surveillance System studies where suitable sampling sites can be located.

Electrical shocking requires a crew of only three men, can be conducted along the shoreline areas in any section of a river, and if conducted both during the day and at night, is effective for most species likely to be encountered. The shocker is reportedly selective for larger fish (Sullivan, 1956) but this was not apparent with the shocking methods used in the present studies.

The electrical shocker as used in these studies should be used at all Water Pollution Surveillance System stations where fishery studies are conducted. Shocking must be conducted both during hours of daylight and darkness to provide representative information on all species. In addition, the catch should be kept separate on possibly 30-minute units-of-effort to provide catch-per-unit-effort data for quantitative comparison of data collected in different seasons or years or at different stations. This was not done in the present studies because initially there was

little confidence in the shocker for large river use. A minimum of four 30-minute units-of-shocking-effort during both daytime and at night should be obtained in future studies.

Sites for setting trammel nets were difficult to locate in the large rivers sampled and there was considerable difficulty with debris. However, where suitable sites (see page 9) can be located the trammel net may take species such as catfish, buffalo, and redhorse which may be inadequately sampled by rotenone and daytime shocking. Night shocking, however, proved to be effective in taking these species and consequently the use of trammel nets was abandoned early in these studies.

Minnow seines and short haul seines (maximum length 100 feet) proved to be very ineffective and suitable sites were seldom available for their use. Their use for these studies was therefore abandoned.

All fish collected with rotenone were sorted to species, counted, weighed and the total length measured to the nearest inch class. The measurements were on a ½-inch interval so that a fish placed in the five-inch class could be from 4.5 to slightly less than 5.5 inches in total length. If a specimen touched the line between inch classes it was placed in the next larger inch class. Fish which could not be positively identified in the field (included most minnows, redhorse and darters) were preserved in 10 per cent formalin for later checking in the laboratory.

Fish collected by electric shocker were treated in the same manner except that at the beginning of these exploratory studies they were not measured. When the effectiveness of the shocker, if used both during the day and at night, became apparent, all fish collected by this method were also routinely measured and grouped into inch classes in the field.

To facilitate comparison, the fish in Tables 1 through 17 are grouped into six major categories based on food habits and methods of feeding.

I. Large, sight-feeding carnivores that feed on other fish. This group includes most game species.

II. Species that feed primarily on insects. This group provides important forage for species in group I.

III. Species that feed primarily on plankton and algae. These also provide important forage for group I species.

IV. Species that feed primarily on mollusks.

V. Omnivores that feed indiscriminately on plant and animal matter from the bottom.

VI. Scavengers that take any available food and are primarily bottom feeders. Some of the species in this group may sometimes act as predators. The group also includes many important food fish and species that are tolerant of degraded conditions.

The common names used for the fish in this report are according to American Fisheries Society Special Publication No. 2, A List of the Common and Scientific Names of Fishes from the United States and Canada, 2nd Edition, 1960.

RESULTS

Tennessee River Basin

Clinch River - Clinton, Tennessee

A total of 9463 fish of 26 different species was collected from the Clinch River in the vicinity of Clinton, Tennessee. Young-of-the-year gizzard shad were overwhelmingly dominant, comprising over 90 per cent of the total number and weight of fish collected by rotenone, and almost 80 per cent of the number collected with the electric shocker (Table 2).

This station is in the relatively unproductive transition zone between a coldwater trout habitat, created by the discharge of cold water from Norris Dam some 13 miles upstream, and the warmwater river habitat several miles downstream. Temperature-wise, it is borderline trout habitat and the year-round cool water temperatures are not suitable for the maintenance of optimum populations of warmwater species. The situation is further complicated by the closure of Melton Hill Dam during the spring of 1963. Clinton is in the very upstream portion of the pool created by the dam and this recent impoundment, together with the lack of an abundance of effective warmwater predators, quite likely accounts for the tremendous reproduction and survival of gizzard shad in the summer of 1963.

Excluding the numerous shad, there were only a few representatives of each of the other species collected and these were predominantly small, young-of-the-year fish. Of considerable significance, from a standpoint of evaluating the habitat, is the collection of a number of rainbow trout by both methods of sampling (Table 2).

With the exception of the tremendous abundance of young-of-the-year shad there appears to have been little change in the fish population indicated by this work and prior studies dating back to 1953 (Table 3). The minor differences can be explained by the difference in location sampled, sampling methods, and time of the year when samples were collected. The 1953 and 1955 samples were collected only a short distance below Norris Dam in relatively shallow, rapidly-flowing coldwater habitat with a concomitant reduction in numbers of species. White

bass move upstream to spawn in early spring and the 1953 samples were collected in May before all of them had moved back downstream into the warmwater section of the river and into Watts Bar Reservoir. Gill nets were used in collecting the 1960, 1961, and 1962 sample data presented and probably account for the large number of species of redhorse collected as compared with the 1963 sampling.

Clinch River - Kingston, Tennessee

A total of 2612 fish of 31 different species was collected from the Clinch River in the vicinity of Gallahers Bridge (Table 4). With the exception of the inexplicable absence of catfish in the samples there appears to be a mixed population typical of a moderate sized warmwater stream in the Tennessee Basin. In addition to the rotenone and shocker samples discussed above overnight trammel net sets in July of 1963 failed to take any species of catfish.

The species composition of the 1963 samples is very similar to those of collections in previous years by the Tennessee Department of Fish and Game and the Tennessee Valley Authority. Catfish were collected by these agencies but not in the immediate vicinity of Gallahers Bridge (Table 5). Although there is no apparent explanation, the only conclusion that can be drawn is that there were few, if any, catfish present in this reach of river at the time of the 1963 sampling.

When samples collected by rotenone and electric shocker were combined by weight, carp made up a larger proportion of the total population than was true at other stations sampled in the Tennessee drainage (Tables 2, 4, 6, 8). The sampled section of river is in the headwaters of Watts Bar Reservoir with many embayments and shallow mud flats which provide excellent habitat for carp.

Specimens of largemouth bass, gizzard shad and carp from this station were qualitatively analyzed for radionuclides by gamma spectrometry. Whole fish were cut up, placed in plastic cylinders and scanned on a 4" x 4" NaI (Tl) detector.

Largemouth bass and carp were scanned for 1500 and 1000 minutes respectively with resultant counts only slightly above background.

Gizzard shad were scanned for 300 minutes and showed a count considerably above background (Figure 14). The distinct photopeaks indicate the presence of Cs^{137}, Ru^{106}, Rh^{106}, Co^{60}, and K^{40}.

Tennessee River - Lenoir City, Tennessee

A total of 379 fish of 21 species was collected with rotenone and the electric shocker from the Tennessee River in the vicinity of Lenoir City, Tennessee (Table 6). Three additional species (black redhorse, river carpsucker, and flathead catfish) were collected with trammel nets. This station is in the turbulent tailwaters of Fort Loudon Dam and the fish population is very difficult to sample. The species composition of the samples collected is what would be expected in the warm tailwater habitat that is present below Fort Loudon Dam. There are no apparent differences in the species present here and those found in the upstream sections of Watts Bar Reservoir (mile 560.5) by TVA biologists in 1957, 1958, 1959, and 1960 (Table 7).

Tennessee River - Chattanooga, Tennessee

The Tennessee River at Chattanooga had a diverse population of warmwater species with a total of 36 species represented in the total collection of 1200 fish (Table 8). The characteristics of the population at Chattanooga are discussed below in conjunction with the Bridgeport samples.

Tennessee River - Bridgeport, Alabama

At the request of the Alabama Department of Conservation rotenone was not used to sample the fish population at this station. A total of 762 fish representing 29 species was collected with the electric shocker and trammel nets.

Both the Bridgeport and Chattanooga stations are in the headwaters of reservoirs, and compositions of the fish populations were very similar (Tables 8 and 9). The area sampled at the Bridgeport station is impounded water and gizzard shad were somewhat more abundant at this station. Although the numerous shallow coves at Bridgeport would appear to provide better habitat for carp, they were considerably less abundant than at Chattanooga. The abundance of scavengers (Group VI) at Chattanooga is probably a reflection of the enrichment from the tanneries located along the river banks in the immediate vicinity of the area sampled.

Discussion - Tennessee River Stations

The Clinch and Tennessee River fish populations were sampled with rotenone, electric shocker, trammel nets, and seines at Water Pollution

Surveillance System stations located near Clinton, Tennessee; Kingston, Tennessee; Lenoir City, Tennessee; Chattanooga, Tennessee; and Bridgeport, Alabama. Faunal differences between stations and unusual features of the populations are a result of differences in type of habitat sampled, particularly in relation to the effect of impoundment on the habitat. With the possible exception of Chattanooga there were no population differences attributable to pollution.

The Clinch River at Clinton would normally be a warmwater habitat; however, releases of cold water from Norris Dam have created an excellent tailwater trout fishery above this station. Clinton lies approximately 13 miles below Norris Dam in the transition zone from a cold to a warmwater habitat. The situation at Clinton is further complicated by the closure (during the spring of 1963) of Melton Hill Dam, which impounds the river at Clinton. The recent impoundment and lack of warmwater predators in this section of river resulted in tremendous reproduction and survival of gizzard shad during the summer of 1963 (Table 2). Young-of-the-year of this species comprised over 90 per cent, by weight, of the fish population sampled at Clinton.

The fish populations at Lenoir City and Kingston, Tennessee are typical of a warm tailwater, and the headwaters of an impoundment, respectively. Kingston, in the headwaters of Watts Bar Reservoir, has a large number of species (31) and a preponderance of carp and buffalo which thrive in the shallow embayments created by impoundment of the river. Lenoir City, in the warm tailwater of Ft. Loudon Dam, had fewer species and a larger proportion of game and pan fish such as largemouth bass, smallmouth bass, spotted bass, sauger, bluegill, and redbreast sunfish, but relatively fewer numbers of carp and buffalo.

Chattanooga had the most diverse population (36 species) with an abundance of carp, buffalo, spotted suckers and adult gizzard shad. Chattanooga had the highest catch rate with the electric shocker of all Tennessee River stations sampled (34.7 lb. per hour as compared with 24.6, 13.0, and 9.7 respectively at Kingston, Bridgeport, and Lenoir City), and with the abundance of scavenger species (carp and buffalo) may show the effects of enrichment from the city of Chattanooga, and particularly from the tanneries located along the river in the vicinity of the area sampled.

The Kingston, Tennessee; Chattanooga, Tennessee; and Bridgeport, Alabama stations are all located in the headwaters of river impoundments and have similar fish populations with an abundance of plankton-feeding shad and scavenger species such as carp and buffalo. Major differences are the higher population levels at Chattanooga discussed above, the low abundance of adult gizzard shad at Kingston (young-of-the-year gizzard shad were abundant) and the complete absence, in the samples, of members of the catfish family at Kingston. Although daytime shocking is not effective for catfish, they should have been collected in the rotenone sample, and in trammel net sets.

Ohio River Basin

Ohio River - Huntington, West Virginia

A total of 2605 specimens representing 42 species was collected in the vicinity of Huntington, West Virginia. Numerically, the population is characterized by an abundance of minnows, primarily emerald, mimic, spotfin and common shiners (Table 10). By weight, the channel catfish and gizzard shad were the dominant species.

The list of species collected is similar to that collected at locks 29 and 30 (downstream from Huntington) during 1957, 1958 and 1959 as reported by Krumholz, et al. (1962) and shown in Table 11. The increased number of species reported in the present study (42 in 1963 as compared with 28 in the combined 1957, 1958 and 1959 collections) may partly be accounted for by the incomplete list of minnows available from the earlier studies.

Spotted bass, smallmouth bass, and several species of redhorse were present in 1963 but were not reported from the earlier lock chamber studies. Sauger and walleye were present in 1958 but were not picked up in 1963. These differences are likely the result of the differences in habitat sampled. Sauger and walleye inhabit the deeper more open water as found in the locks, while the redhorse, and particularly the two species of black bass, are more likely to be found in the shallow, shoreline areas that were sampled in 1963.

A striking feature of the fish population at Huntington in 1963 was the paucity of mature, adult fish in the samples collected. Of the total 2605 specimens captured, only ten fish were over 12 inches in total length. Five of 348 channel catfish, the dominant species by weight, exceeded 12 inches in total length. Other than minnows, almost the entire collection was made up of young-of-the-year fish.

A second unusual feature of the fish population at Huntington was the high incidence of disease and parasitism. Twenty-three per cent of the minnows collected were parasitized by "anchor worms" (Lernaea sp.) and had a considerable amount of secondary fungal infection in the vicinity of the lesions caused by these parasites. Open sores of unknown origin were also noted on golden redhorse, spotted sucker, white sucker, and brindled madtom.

Channel catfish collected at this station had external lesions on the caudal peduncle and in the vicinity of the dorsal fin. Histopathological examination of these lesions by Mr. Paul P. Yevich of the Public Health Service Occupational Health Research and Training Facility indicated a proliferation of protozoan parasites of unknown species between the muscle and epidermis. Lesions on largemouth bass from the same station examined by Mr. Yevich were typical of lymphocystis, a virus-caused disease, which is reportedly common on the walleye from some northern waters.

Ohio River - Cincinnati, Ohio

A total of 14,039 specimens representing 48 species was collected with rotenone and the electric shocker in the vicinity of Water Pollution Surveillance System Station Number 37 at Cincinnati, Ohio. The population composition was similar to that found at Huntington with a numerical dominance of minnows, primarily emerald shiners (Table 12). By weight, the gizzard shad, channel catfish, and emerald shiner were dominant.

From the standpoint of numbers of species, abundance of desirable food and game fish such as largemouth bass, smallmouth bass, spotted bass, and channel catfish in a wide range of sizes, the Cincinnati station has an excellent fish population typical of a relatively unpolluted warmwater river. It should be noted, however, that the Water Pollution Surveillance System station at Cincinnati is upstream from the effects of pollution from the Little Miami River and the City of Cincinnati.

Considerably more species (48 as compared with 25) were found in 1963 than reported for lock chamber studies conducted by the Kentucky Department of Fish and Wildlife Resources in 1957, 1958 and 1959 (Table 13). A part of this difference is the absence of data for most of the minnows collected in the earlier studies. However, although they were abundant in 1963, none of the three species of black bass were taken in the lock chamber samples. This is very likely a result of the difference in habitat sampled.

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Ohio River - Louisville, Kentucky

A total of 2430 specimens representing 27 species was collected with rotenone and electric shocker in the vicinity of Water Pollution Surveillance System Station Number 84 at Louisville, Kentucky (Table 14). Numerically, emerald shiners dominated the population. By weight, gizzard shad were by far the dominant species, followed by channel catfish and carp.

On the basis of these samples the Ohio River at Louisville has the largest population of large sport fish of any Ohio River station sampled. Largemouth, smallmouth, and spotted bass comprised 19.8 per cent, by weight, of the fish collected with the electric shocker. These three species of black bass were not collected in lock samples made by the Kentucky Department of Fish and Wildlife Resources in 1957, 1958, and 1959 (Table 15).

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Ohio River - Evansville, Indiana

A satisfactory sample of the fish population at Evansville was not obtained with either rotenone or the electric shocker. The mouth of the small creek sampled with rotenone was almost devoid of fish and was reported by Kentucky Department of Fish and Wildlife Resources biologists to be polluted by toxic wastes. Most of the fish collected with rotenone (Table 16) were picked up along the shoreline of the Ohio River downstream from the creek mouth. At the time of the Evansville sampling the electric shocker was not being used at night and the data in Table 16 represent only daytime shocking.

A total of 1677 specimens representing 18 species was collected by the two methods of sampling. Emerald shiners, gizzard shad and freshwater drum were very abundant at this station. Sampling with the electric shocker, a concentration of gizzard shad, river carpsucker and quillback carpsucker was found in the immediate vicinity of the Evansville sewage treatment plant outfall.

A total of 28 species was reported from lock samples collected in 1957, 1958, and 1959 by the Kentucky Department of Fish and Wildlife Resources biologists (Table 17). As was true in other lock samples reported at upriver stations, no black bass were found in the locks.

Discussion - Ohio River Stations

The Ohio River fish population was sampled with rotenone and electric shocker at Huntington, West Virginia; Cincinnati, Ohio; Louisville, Kentucky; and Evansville, Indiana.

All the Ohio River stations sampled had a diverse population of species typical of a large warmwater river. A high of 48 species was collected at Cincinnati with a low of 18 species at Evansville. As pointed out previously the Evansville samples were considered inadequate to fully characterize the fish population at Evansville and unless specifically mentioned the following discussion will not allude to the Evansville data.

The Ohio River is characterized by an unusually abundant minnow population with emerald shiners comprising from 53.8 per cent to 87.8 per cent of the total number of specimens collected with the electric shocker. River shiners, spotfin shiners, and mimic shiners were also common at all stations.

Other than the minnows, seven species (gizzard shad, channel catfish, skipjack, freshwater drum, and three species of black bass) were common and abundant at all Ohio River stations. Of these seven the channel catfish and gizzard shad were most abundant and with the emerald shiner comprised the bulk of the population at all stations.

The population of desirable game fish was high with three species of black bass, largemouth, smallmouth, and spotted bass comprising 11.7, 22.2 and 19.8 per cent of the total weight of fish collected with the electric shocker at Huntington, Cincinnati, and Louisville, respectively. These three species of bass, and particularly the smallmouth, are considered to be relatively intolerant of organic pollution.

The sand shiner and mimic shiner have been mentioned by some authors as being clean water species that cannot withstand pollution (Krumholz, et al., 1962). The mimic shiner was common at all three stations sampled, while the sand shiner was a dominant component of the minnow population at Huntington but was not collected at the downstream stations.

On the basis of catch-per-unit-effort with the electric shocker the station at Louisville had the largest standing crop with a catch-per-hour of 46.3 lb., as compared with 19.2 and 9.3 lbs. respectively at Cincinnati and Huntington. The difference is attributable to the abundance of large catfish, largemouth bass, and carp collected with the shocker at Louisville (Table 14).

Huntington was somewhat unusual in that very few adult fish were collected and almost the entire collection was composed of young-of-the year fish. The incidence of disease and parasitism was also high at Huntington with many minnows parasitized by "anchor worms". Channel catfish had lesions caused by protozoan parasites, and some of the largemouth bass and spotted bass had lymphocystis disease. A few parasitized minnows as well as two bass with lymphocystis disease were collected at Cincinnati. Parasitized and diseased fish were not noted at Louisville and Evansville.

With the exception of some unusual circumstances at Huntington and reported problems in relation to palatability at both Huntington and Cincinnati, the fish populations at the Ohio River stations sampled do not appear to be seriously affected by pollution. All stations sampled had an excellent population of desirable game and food species and a diverse population of forage species composed of both plankton and insect feeders (Figure 13). The population at Louisville is particularly excellent with an abundance of large black bass and channel catfish. However, according to local residents and fishermen, the fish at Huntington and Cincinnati are not palatable and therefore, worthless from a commercial standpoint. Palatability would certainly also reduce their value from the standpoint of the sport fisherman. Therefore, although excellent fish populations are present, particularly at Cincinnati, pollution may be having a deleterious affect by rendering the populations worthless as food. These reports should be investigated.

The reason for the paucity of adult fish in late summer and the high incidence of disease and parasitism at Huntington is not known to the author. Several valid hypotheses are possible. It is possible that

pollution effects might weaken the resistance of fish in the area to disease and parasitism. In addition it is very possible that under low flows and higher temperatures of late summer adult fish find conditions intolerable and move out of the area leaving behind the less mobile young-of-the-year. The situation at Huntington is certainly worthy of further study.

Cumberland River Basin

Cumberland River - Clarksville, Tennessee

A total of 638 fish of 40 different species was collected from the Cumberland River in the Vicinity of Clarksville, Tennessee (Table 18). The fish population is somewhat similar to that collected from the Ohio River, with an abundance of emerald shiners and gizzard shad. The primary difference is the abundance of redhorse in the Cumberland River samples.

The Cumberland, an upland stream with clean bottom and an abundance of mollusks (an important food of redhorse), is more suitable habitat for redhorse than the more silted lower sections of the Ohio River which were sampled. Most species of redhorse will tolerate at most only mild pollution and are found in streams with sufficient gradient to keep the stream bottom comparatively free of silt.

Conclusion

Two methods of sampling, rotenone and electric shocker, appear to be suitable for obtaining adequate data on the rivers sampled. Utilizing these two sampling methods for obtaining data, the fish population at Water Pollution Surveillance System stations were evaluated on the basis of the species present, their relative abundance and size distribution. These parameters are sufficient to characterize the suitability of the habitat for fish and can be obtained with a minimum of time and effort. As pointed out under the previous discussion of methods, an additional valuable parameter amenable to quantitative comparison, namely, catch-per-unit-of-effort with the electric shocker, can and should be obtained in future studies.

It should be emphasized that in evaluating fish population data a number of factors other than the water medium are of importance. Depth, volume of flow, slope, types of substrate, amount and types of shelter, availability and suitability of spawning sites, available food and accessibility of tributaries all may affect the structure of the fish population. Because of these confounding factors, comparisons of fish sample data with other physical and chemical parameters measured by the WPSS must be approached with caution, and only on the basis of a thorough knowledge of the habitat sampled. Likewise, it is impossible to locate and sample the same type of habitat at every station and therefore, comparisons between stations may be subject to a great deal of error

These difficulties are exemplified by a comparison of data from the Clinch River at Clinton, Tennessee, with that from other stations in the same watershed. Only 26 species were collected at Clinton (the lowest number of any station in the Tennessee basin) and over 90 per cent of the population was composed of young-of-the-year gizzard shad when sampled in the summer of 1963. The few game and pan fish taken were of small size. This would be considered a poor fish population by any standards. Nevertheless, the Clinch River in this area probably has the cleanest water of any station sampled in the Tennessee basin. As previously discussed, the fish population at Clinton is a result of the effects of two reservoirs on the physical characteristics of the habitat.

By sampling year after year under similar conditions of flow and temperature, in the same habitats, and with the same gear, the effects of the confounding factors discussed above will be minimized and changes in the fish population structure may be related to physical and chemical changes in the water medium at a particular station.

Literature Cited

1. Doudoroff, Peter and Charles E. Warren
   1957. Biological Indices of Water Pollution, with Special Reference to Fish Populations. Trans. of a Seminar on Biol. Prob. in Water Poll. R. A. Taft San. Eng. Center, Cincinnati, Ohio, pp. 144-163.

2. Katz, Max and Arden Gaufin
   1953. The Effects of Sewage Pollution on the Fish Population of a Midwestern Stream. Trans. Am. Fish. Soc. 82:156-165.

3. Krumholz, Louis A., James R. Charles and W. L. Minckley
   1962. The Fish Population of the Ohio River. Aquatic-Life Resources of the Ohio River, pp. 51-89, published by the Ohio River Valley Water Sanitation Commission, Cincinnati, Ohio

4. Patrick, Ruth
   1950. Biological Measure of Stream Conditions. Sew. and Ind. Wastes. Vol. 22(7):926-938.

5. Pfitzer, Donald W.
   No date. Investigations of Waters Below Large Storage Reservoirs in Tennessee. Final Report, DJ Project F-1-R, Tenn. Game and Fish Commission, Nashville, Tenn.

6. Sullivan, Carl
   1956. The Importance of Size Grouping in Population Estimates Employing Electric Shockers. Prog. Fish Cult. 18(4):188-190.

7. Swingle, H. S.
   1950. Relationships and Dynamics of Balanced and Unbalanced Fish Populations. Ala. Agric. Exp. Sta. Bull. #274, 74 pp.

8. Swingle, H. S.
   1954. Fish Populations in Alabama Rivers and Impoundments. Trans. Am. Fish.Soc. for 1953., Vol. 83:47-57.

9. Thomas, Nelson A.
   1963. An Electrofishing Electrode with Controllable Amperage Output. Prog. Fish. Cult. 25(3):166-167.

10. Tebo, L. B., Jr.
    1959. Comparison of Fish Populations in Polluted and Non-Polluted Arms of a Warmwater Reservoir. Proc. 13th Ann. Conf. S. E. Assoc. of Game and Fish Comm. 220-228.

APPENDIX I

DESCRIPTION OF AREAS SAMPLED

Tennessee River Basin

Clinch River, Water Pollution Surveillance System Station #119, at Clinton, Tennessee:

This station is located on the west side of the Clinch River at the Clinton Water Treatment Plant at river mile 66.2 (Figure 3).

Prior to the spring of 1963 the Clinch River at this station was a medium-sized, coldwater river whose flow fluctuated daily according to the releases from Norris Dam approximately 13 miles upstream. During the 1960-1961 water year the streamflow ranged from a low of 86 cfs during October to a high of 19,300 cfs during March.

During the spring of 1963 Melton Hill Dam at river mile 23 was completed and closed. The station lies at the very upstream limit of impounded water and the flow varies from swift to imperceptible, depending on releases from Norris and the level of Melton Hill Reservoir.

The river is approximately 400 feet wide at the Water Pollution Surveillance System sampling point and has a bottom of bedrock and large boulders. Much of the shoreline is steep, with little escape cover for fish.

No Water Pollution Surveillance System temperature data are available; however, the station is within the Norris tailwater area, which is stocked and managed for rainbow trout by the Tennessee Department of Fish and Game. According to a report by Pfitzer (no date) the temperature during 1951 ranged from 42° to 70° F.

Rotenone samples were collected behind Clinton Island at river mile 60.5 and in a small cove in Eagle Bend at river mile 62.2. The electric shocker was used in the shallow riffle area just above Highway 61 bridge and along the east bank just below the treatment plant near the mouth of Hinds Creek (Figure 3).

Clinch River, Water Pollution Surveillance System Station #106 at Kingston, Tennessee:

This station is located on the north shore of the Clinch River at Gallahers Bridge at river mile 14.5 (Figure 4).

The Clinch River at this station is in the headwaters of Watts Bar Reservoir and in the tailwaters of Melton Hill Dam located at Clinch River mile 23. There is a very slight flow, and the water movement reverses itself frequently, depending on the operation of Melton Hill and Watts Bar Dams.

During the 1961-1962 water year the average daily flow ranged from a low of 266 cfs during October to a high of 20,100 cfs during March.

The river is approximately 500 feet wide at the Water Pollution Surveillance System sampling point. It flows through rolling, heavily-wooded country, and except in areas where there are steep, eroded banks, the shrubs and trees grow to the water's edge. This shoreline vegetation is periodically inundated by the fluctuating water level and provides abundant cover for fish. There are numerous coves formed by the impoundment of the mouth of many small tributary streams.

The habitat is that of a typical warmwater reservoir; however, releases from Melton Hill Dam some eight miles upstream will undoubtedly alter the temperature regimen, with consequent changes in the suitability of the habitat for species formerly present.

Rotenone samples were collected from a cove near Hensley Cemetery at river mile 16.4 and from a small cove on the east shore at river mile 14.7 (Figure 4). The electric shocker was used during daylight hours along the shoreline of a cove on the east shore at river mile 16.1, along both sides of the larger cove from Roberts Branch at river mile 13.5, and along both shores of the Clinch River between river miles 14.0 and 14.5 (Figure 2).

Tennessee River, Water Pollution Surveillance System Station #107 at Lenoir City, Tennessee:

This station is located on the north bank of the Tennessee River at the Lenoir City Municipal Water intake, which is just opposite the mouth of the Little Tennessee River at river mile 601.2 (Figure 5).

The Tennessee River at Lenoir City is in the tailwaters of Fort Loudon Reservoir. The dam is located just a few hundred yards upstream from the Water Pollution Surveillance System sampling station, and the flow is very swift and turbulent.

During the 1961-1962 water year the streamflow ranged from 13,400 cfs to 56,600 cfs. The river is approximately 800 feet wide at the Water Pollution Surveillance System sampling point. Incomplete Water Pollution Surveillance System temperature data are available; however, the releases from Fort Loudon Dam are warm and temperatures as high as 28°C were recorded during August 1962.

Much of the shoreline along the south bank in the vicinity of this station is steep, with high cliffs and outcroppings of bedrock. Here the water along the shoreline is fairly deep and has excellent cover for fish in the form of large boulders and fallen trees. Some of the

north bank is of soft, alluvial, easily-eroded soils. The bottom of the channel is scoured by the swift current, and is composed of bedrock, rubble and gravel.

A rotenone sample was collected between Browder Island and the shore proper at river mile 597.2. The electric shocker was used along the south bank between river mile 597.5 and 598.5 and along both banks between river miles 599.5 and 600.5 (Figure 5).

Tennessee River, Water Pollution Surveillance System Station #51 at Chattanooga, Tennessee:

This station is located at the Chattanooga Water Company intake at river mile 465.3 (Figure 6).

The Tennessee River at Chattanooga is in the headwaters of Hales Bar Reservoir. This is a warmwater fish habitat with a moderately swift current.

During the 1961-1962 water year the average daily flow ranged from 14,000 cfs during September to 176,000 cfs during December. During the same period the daytime water temperature ranged from 5.6°C during January to 26.9°C during August. The river is approximately 1100 feet wide at river mile 464.

Effluent from the city of Chattanooga and the tanneries enters the river via Chattanooga Creek, which is about 4.5 miles below the Water Pollution Surveillance System sampling station, but in the vicinity of the area where the fish samples were collected (Figure 6). Numerous industries are located along the shoreline on the east side of the river, and at the time of sampling there was a considerable amount of sewage debris in the vicinity of the island at river mile 461.4.

There is abundant cover in the form of rock fill along the east shore and snags and debris along the alluvial western shoreline.

Rotenone samples were collected behind the island at river mile 461.2 and in a small cove on the north shore at river mile 453.9. The electric shocker was used along both shores between river mile 460.1 and 461.2 (Figure 6).

Tennessee River, Water Pollution Surveillance System Station #77 at Bridgeport, Alabama:

This station is located at the TVA Widows Creek Steam Plant at river mile 407.5 (Figure 7).

The Tennessee River at Bridgeport is in the headwaters of Guntersville Lake and there are numerous coves and backwater areas (Figure 5).

The current is sluggish and during the 1961-1962 water year the average daily streamflow ranged from 13,800 cfs during October to 183,000 cfs during December. The daytime water temperature ranged from 4.8°C during January to 27.0°C during July. The river channel is approximately 1500 feet wide at river mile 402, which is 6 miles below the Water Pollution Surveillance System sampling point. The shoreline is sandy and alluvial, with abundant cover in the form of rooted aquatic plants, snags, and fallen trees. Along the west shoreline there are outcroppings of shale.

Samples were collected with the electric shocker along both banks between river mile 400.0 and 401.4 and in a small cove on the west bank at river mile 397.7 on June 12. Trammel nets were set on June 12 and 13 at the lower end of Crow Creek Island, river mile 400.8, and along the west bank at river mile 398.0 (Figure 7).

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Cumberland River, Water Pollution Surveillance System Station #70 at Clarksville, Tennessee:

This station is located on the east shore of the Cumberland River at the intake of the Clarksville Water Treatment Plant at river mile 132.7 (Figure 8).

The Cumberland River in the vicinity of Clarksville flows in a deep, narrow channel with high, cut banks on each side and occasional steep bluffs of solid bedrock.

The current is swift and during the 1961-1962 water year the average daily streamflow ranged from a low of 3360 cfs during September to a high of 199,000 cfs during March. The channel is approximately 600 feet wide at the Water Pollution Surveillance System sampling point.

No Water Pollution Surveillance System temperature data are available; however, from a fisheries standpoint this is a warmwater habitat. There is abundant shoreline fish cover in the form of large boulders and fissures in the bedrock.

There are no major tributaries and no apparent sources of major pollution in the immediate vicinity of the station.

Rotenone samples were collected in the mouth of Cooks Branch at river mile 134.8 and behind the lower end of Seven Mile Island at river mile 131.7. The electric shocker was used during the day and at night along the east bank above the water plant intake, from river mile 132.8 to river mile 135.0, including Cooks Branch. The shocker was also used along both shores below the water plant intake from river mile 131.0 to river mile 132.0 (Figure 8).

Ohio River Basin

Ohio River, Water Pollution Surveillance System Station #38, at Huntington, West Virginia:

This station is located on the south shore of the Ohio River at river mile 304.2, approximately one mile above the mouth of the Guyandotte River (Figure 9).

The Ohio River at Huntington, West Virginia is a large warmwater river with minimum flows maintained by the U. S. Corps of Engineers, Greenup Lock and Dam, at river mile 340. The next upstream lock and dam is Racine at mile 235.

During the 1960-1961 water year the average daily streamflow ranged from a low of 7010 cfs during October to a high of 333,000 cfs during March. The daytime water temperature ranged from 2.1°C in January 1961 to 29.2°C in September 1961.

The river is approximately 1300 feet wide at the Water Pollution Surveillance System sampling point. The shoreline is generally shallow and gradually sloping with a bottom of alluvial sand and silt and very little cover for fish. The bottom in the channel is composed of gravel and rubble.

The Guyandotte River, which enters immediately below the Water Pollution Surveillance System station, appeared to be badly polluted, and dead and distressed fish were observed in this river when the station was sampled in September.

At the time when the fish samples were collected there were numerous growths of sewage fungus observed on fallen trees and debris along the north shore in the vicinity of, and upstream from, the Water Pollution Surveillance System sampling station.

Rotenone samples were collected along the north shore behind the partial enclosure created by old lock #27 wall at river mile 300.8 and in the mouth of Paddys Creek at river mile 303.8. Samples were collected with the electric shocker during the day and at night along the south shore between river mile 301 and 304 (Figure 9).

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Ohio River, Water Pollution Surveillance System Station #37 at Cincinnati, Ohio:

This station is located at the intake of the Cincinnati Municipal Water Plant, which is on the north shore of the Ohio River near river mile 462.9 (Figure 10).

During the winter of 1962-1963, the Ohio River at Cincinnati was impounded by Markland Lock and Dam at river mile 535. Markland creates what essentially amounts to a run-of-the-river reservoir with many of the creek mouths and shallow coves along the shoreline impounded. Depending on streamflow the current in the channel is moderately swift.

During the 1960-1961 water year the average daily streamflow ranged from a low of 8,530 cfs during October to 430,000 cfs during March. The daytime water temperature ranged from 1.3°C during December 1960 to 29.4°C during September 1961. Except during periods of high rainfall the water is quite clear with secchi disk readings in excess of 24 inches.

The river is approximately 1400 feet wide at the Water Pollution Surveillance System sampling point. The shoreline is quite variable with steep banks along part of the south shore and good cover in the form of large rocks and boulders. The north shore has a shallow, sloping shoreline with a bottom of sand and clay. In protected areas and near the mouths of tributaries, there are deep deposits of silt and organic detritus. The bottom in the deeper channel portion of the river is composed of sand, gravel, and coal particles.

Rotenone samples were collected in a large dead-end cove on the south shore at river mile 461.3 and on the north shore in the mouth of Five Mile Creek at river mile 459.5. Samples were collected during the day and at night with the electric shocker along the south shore between river mile 460 and 463 and along the north shore in the vicinity of Five Mile Creek.

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Ohio River, Water Pollution Surveillance System Station #84, at Louisville, Kentucky:

This station is located on the south shore of the Ohio River at the intake of the Louisville Water Company filter plant near river mile 600.8 (Figure 11).

The Ohio River at Louisville is impounded by McAlpine Lock and Dam at river mile 607 and the channel is deep (in excess of 40 feet at normal flows) with a moderate current speed.

During the 1960-1961 water year the average daily streamflow ranged from a low of 8,640 cfs during September 1961 to a high of 587,000 cfs during March 1961.

The river is approximately 1800 feet wide at the Water Pollution Surveillance System sampling point. The south shore is generally shallow, with a gradual slope and little cover. In a few places along the south shore rock road fill furnishes cover and a more steeply sloping bottom near shore. The north bank is fairly steep but of easily erodable soil,

so that there is a shallow shelf of silt and then a dropoff of several feet to a bottom of sandy clay. The channel bottom is composed of sand, gravel, and clay.

There are no major tributaries in the vicinity of this station.

One rotenone sample was collected in the mouth of Fourteen Mile Creek at river mile 589. Samples were collected with the electric shocker both during the day and at night along the north and south shores of the river between river miles 598.0 and 599.5 in the vicinity of Six Mile Island (Figure 11).

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Ohio River, Water Pollution Surveillance System Station #36, at Evansville, Indiana:

This station is located on the east bank of the Ohio River at the Evansville Municipal Water Plant intake at river mile 794 (Figure 12).

The Ohio River at Evansville is fairly wide and shallow, with sandbars at bends and low-water sandy islands in midstream. Much of the adjoining land is laced by sloughs and barely above the high-water mark. This low swampy land is protected by numerous levees built along both shores.

During the 1960-1961 water year the average daily streamflow ranged from 14,000 cfs during October 1960 to 626,000 cfs during May 1961. The daytime water temperature ranged from 1.9°C during January 1961 to 28.7°C during September 1961.

The river is approximately 3,000 feet wide at the Water Pollution Surveillance sampling point. Except in the deep channel and along the rock levees, the bottom is of shifting sand and silt. The shoreline is rather steep along the rock levees and the large boulders used in levee construction provide excellent cover for fish.

Except for Pigeon Creek, whose mouth is approximately one mile below the Water Pollution Surveillance sampling point (Figure 12), there are no major tributaries in the vicinity of this station.

One rotenone sample was collected at the mouth of Canoe Creek at river mile 807. The electric shocker was used along both shores above the water plant intake between river miles 793 and 794 and below the water plant intake between river miles 796 and 797.

APPENDIX II

FIGURES

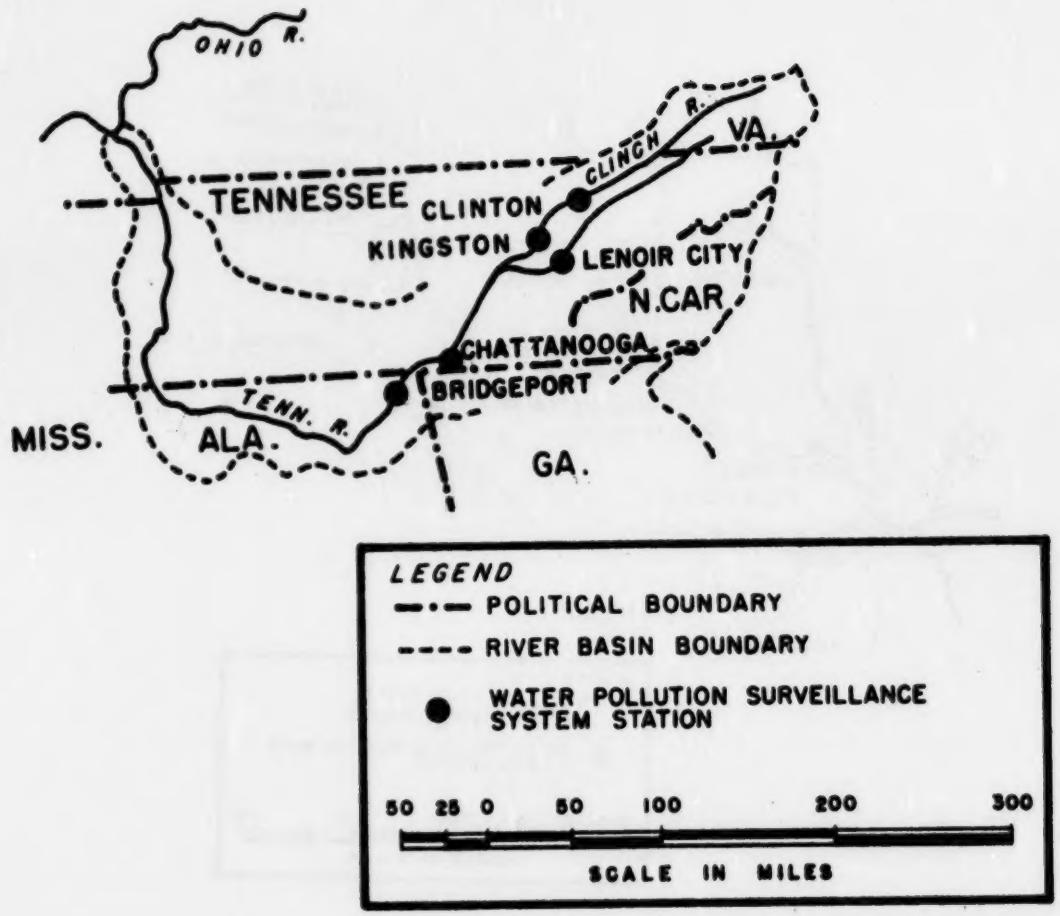

OHIO R.
TENNESSEE
CLINTON
KINGSTON
CLINCH R.
VA.
LENOIR CITY
N.CAR
CHATTANOOGA
BRIDGEPORT
TENN. R.
MISS.
ALA.
GA.
LEGEND
POLITICAL BOUNDARY
RIVER BASIN BOUNDARY
WATER POLLUTION SURVEILLANCE SYSTEM STATION
50 25 0 50 100 200 300
SCALE IN MILES

Figure 1

NEW YORK
PENNSYLVANIA
ALLEGHENY R.
PITTSBURGH
WABASH R.
INDIANA
OHIO
L. MIAMI R.
CINCINNATI
MONONGAHELA R.
OHIO RIVER
HUNTINGTON
KANAWHA R.
LOUISVILLE
MISS. RIVER
ILLINOIS
EVANSVILLE
WEST VIRGINIA
KENTUCKY
CAIRO
CLARKSVILLE
CUMBERLAND R.
TENNESSEE
TENNESSEE R.
LEGEND
POLITICAL BOUNDARY
RIVER BASIN BOUNDARY
WATER POLLUTION SURVEILLANCE SYSTEM STATION
50 25 0 50 100 200 300
SCALE IN MILES

Figure 2

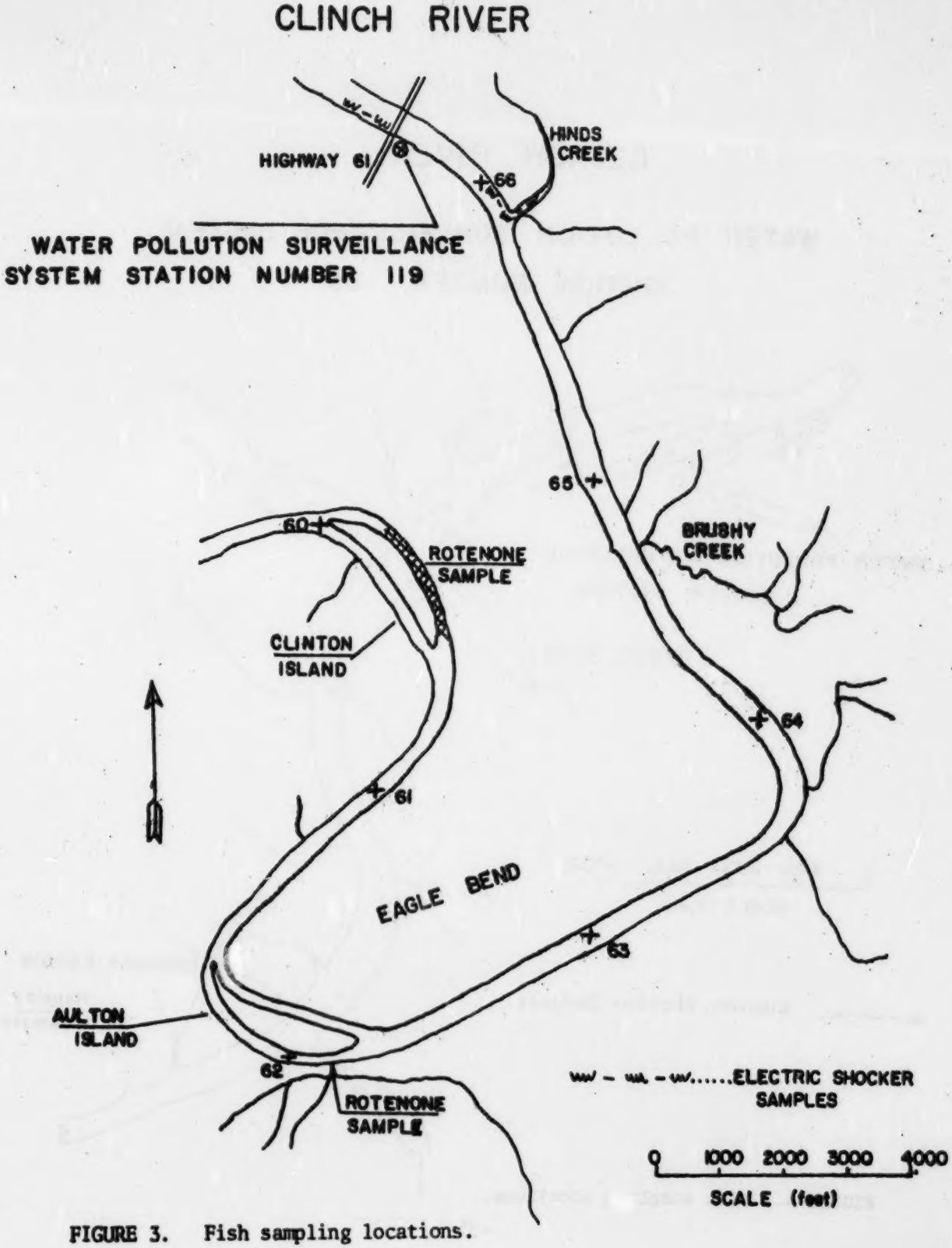


FIGURE 3. Fish sampling locations.

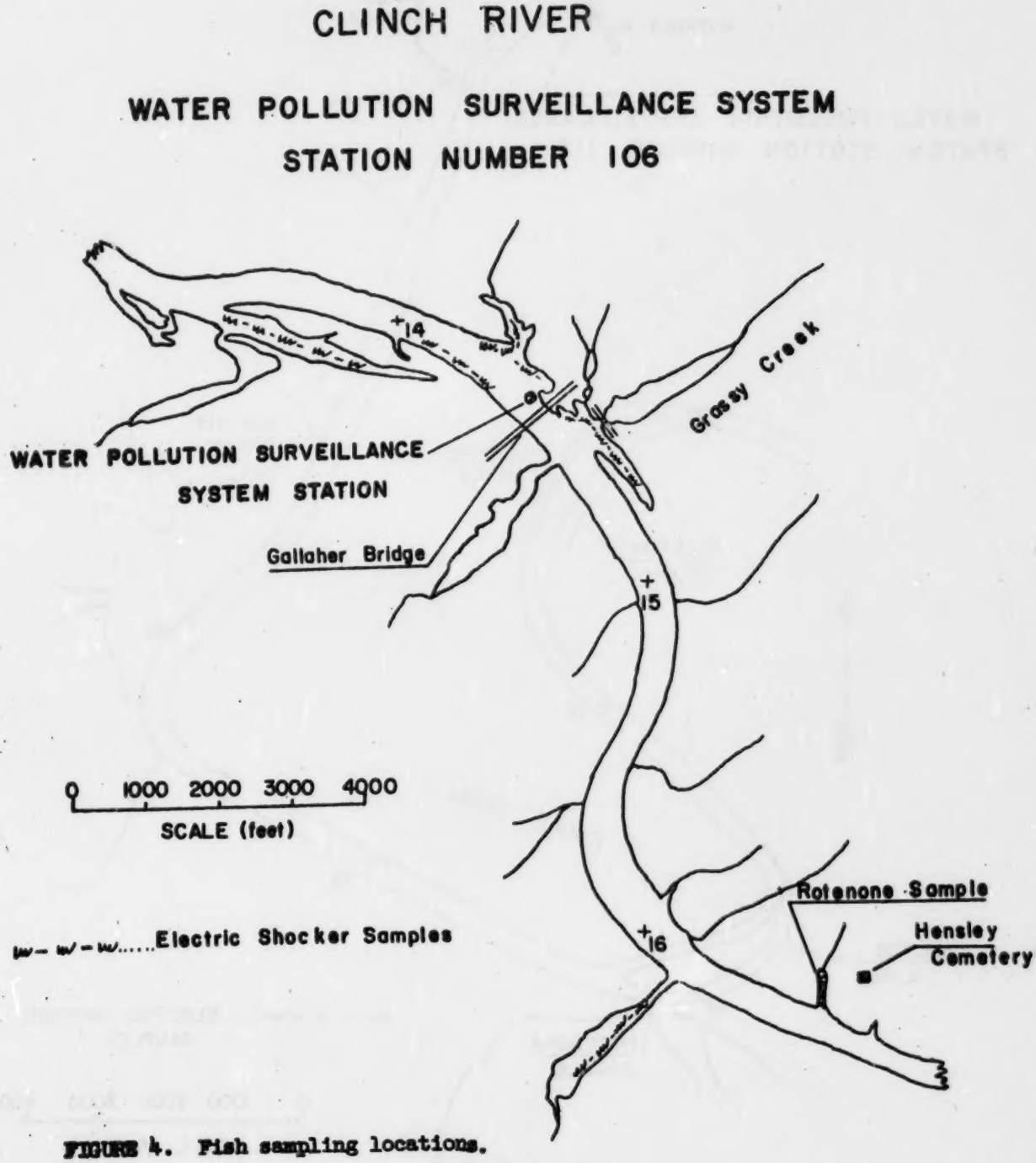


FIGURE 4. Fish sampling locations.

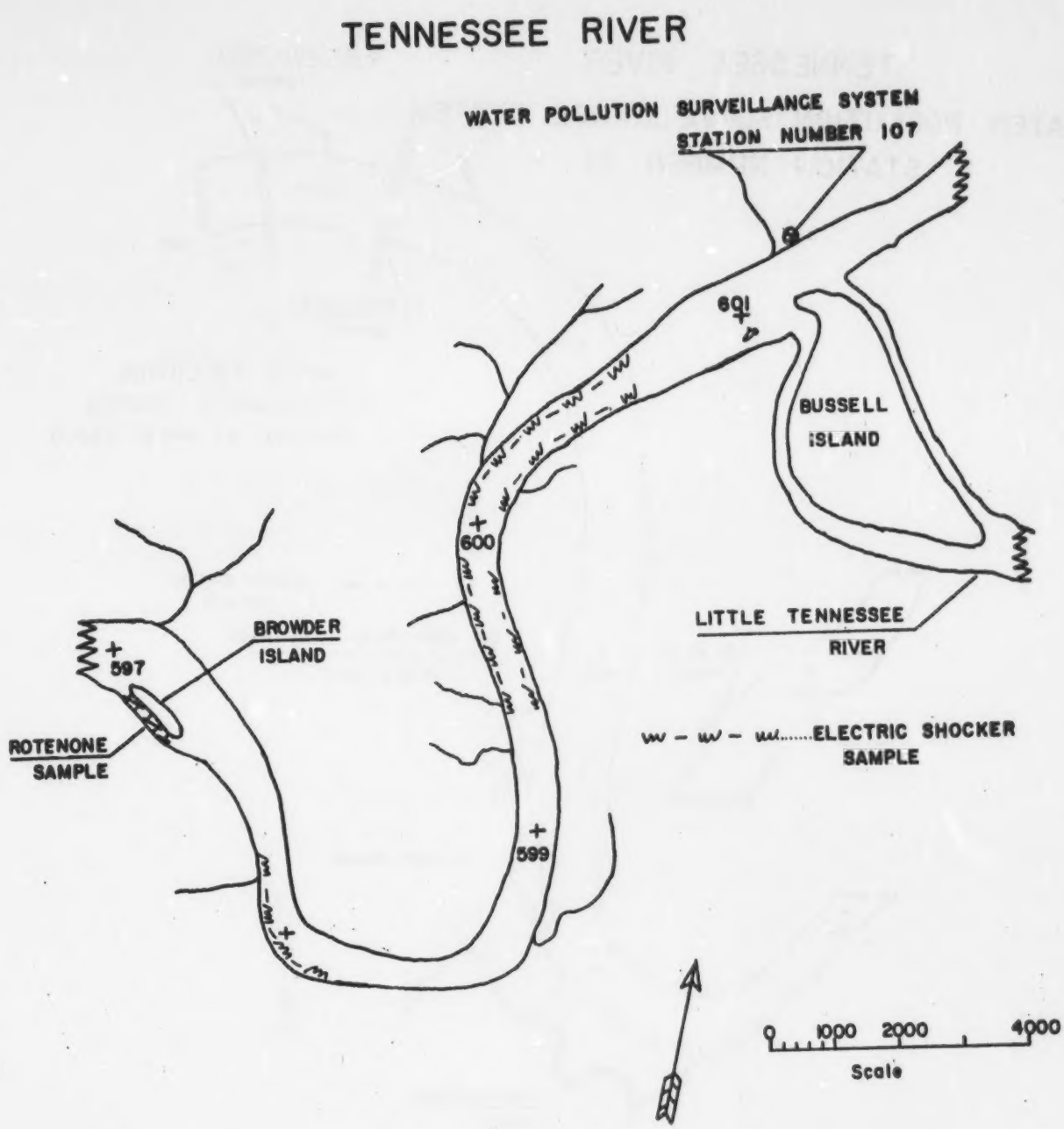


FIGURE 5. Fish sampling locations.

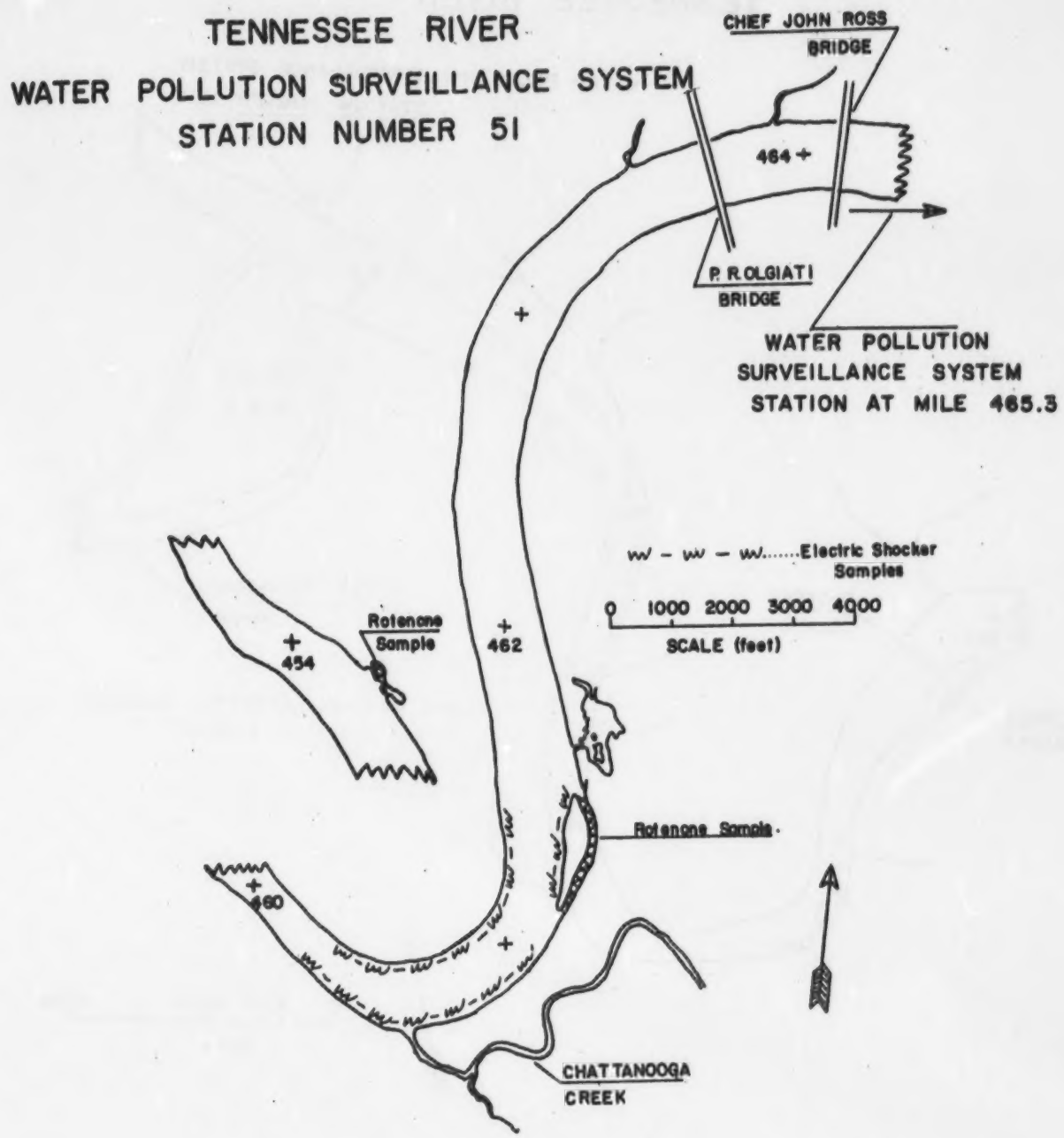


FIGURE 6. Fish sampling locations.

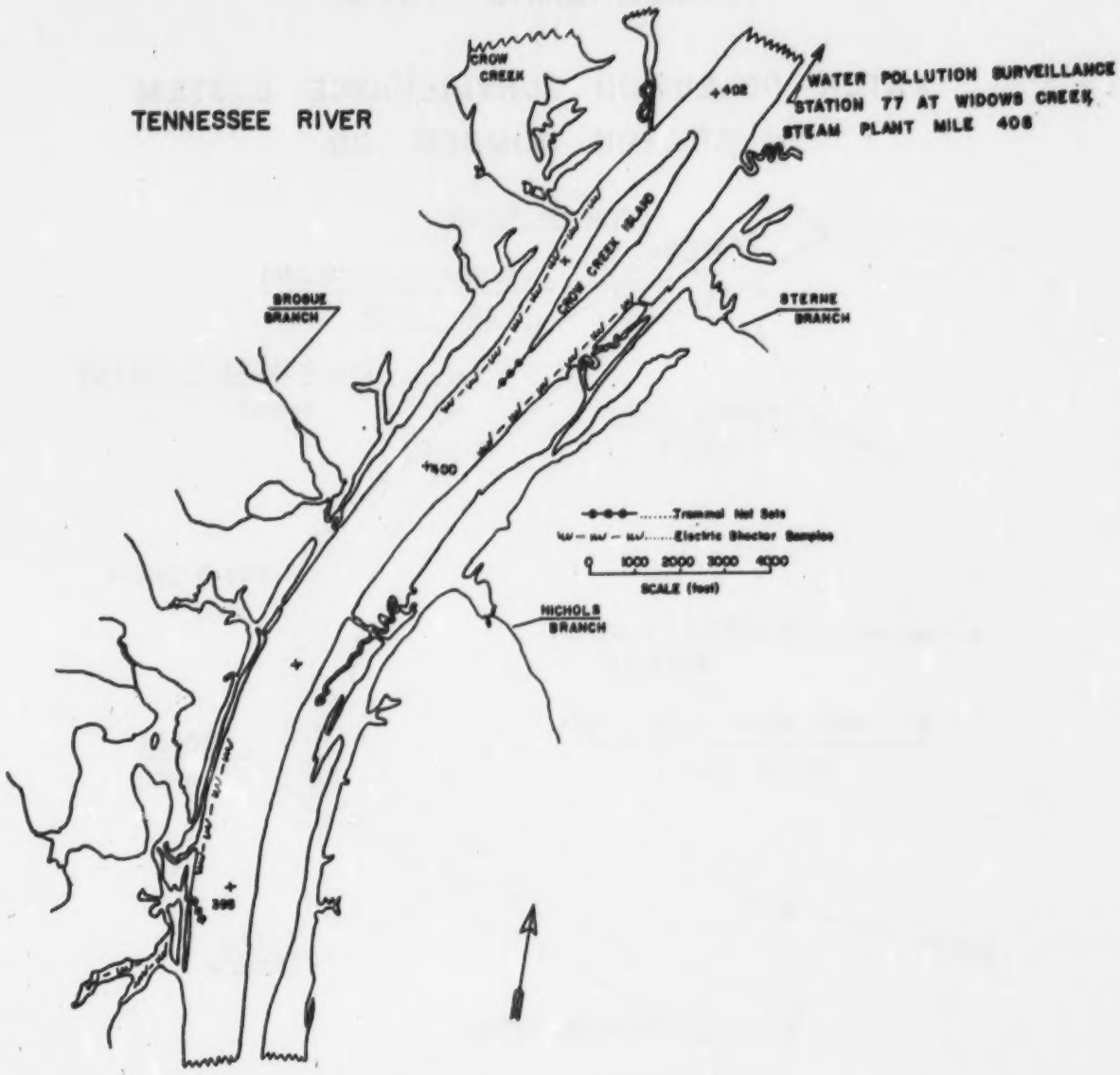


FIGURE 7. Fish sampling locations.

CUMBERLAND RIVER

WATER POLLUTION SURVEILLANCE SYSTEM
STATION NUMBER 70

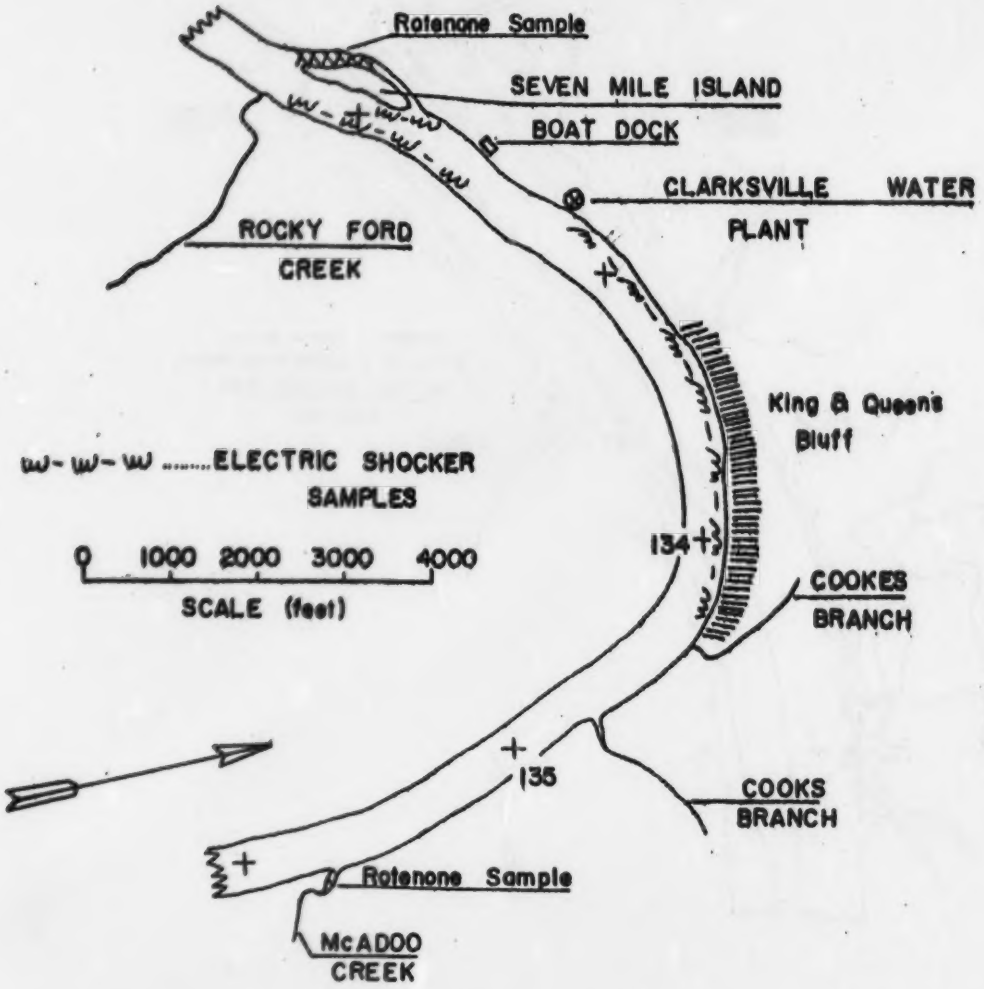


FIGURE 8. Fish sampling locations.

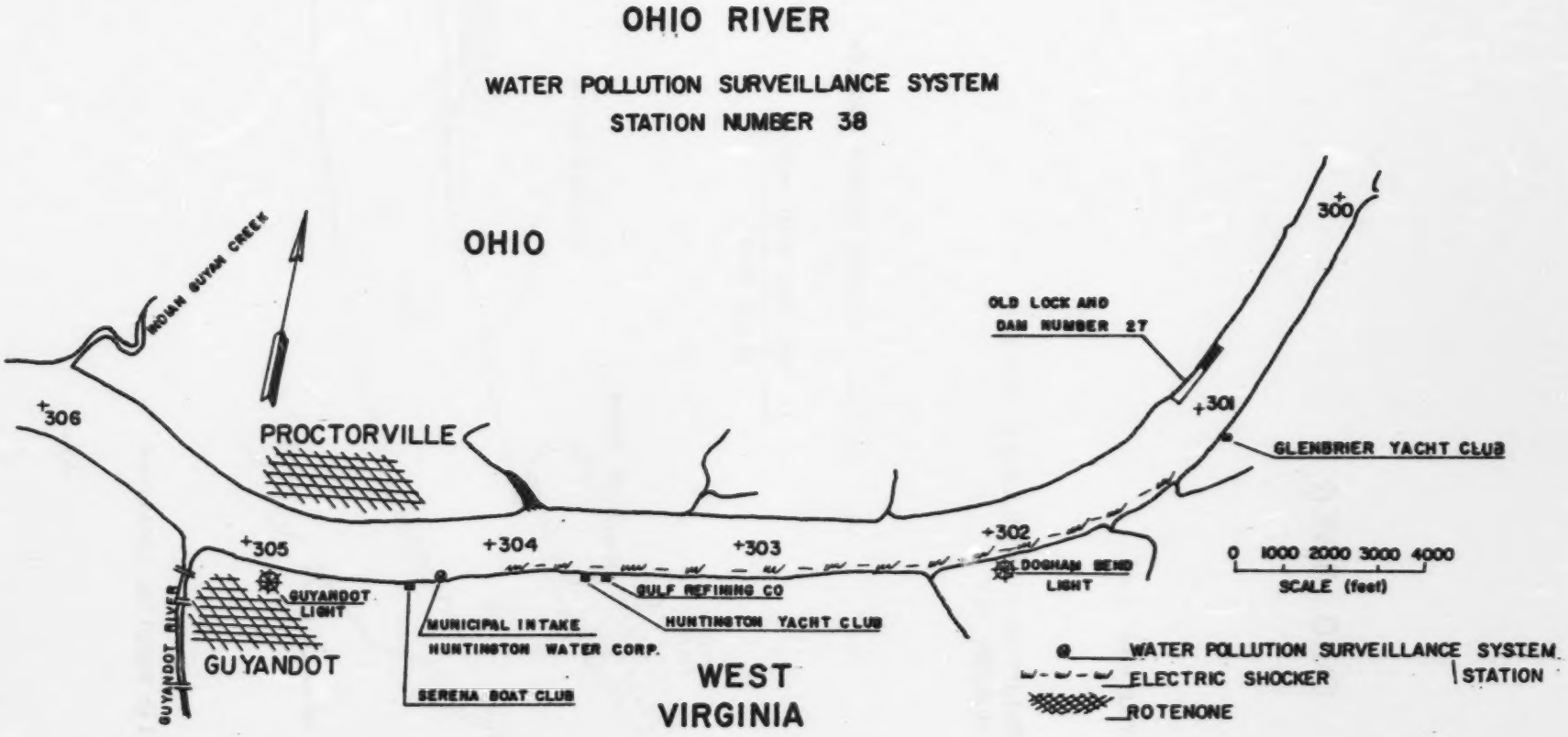


FIGURE 9: Fish sampling locations.

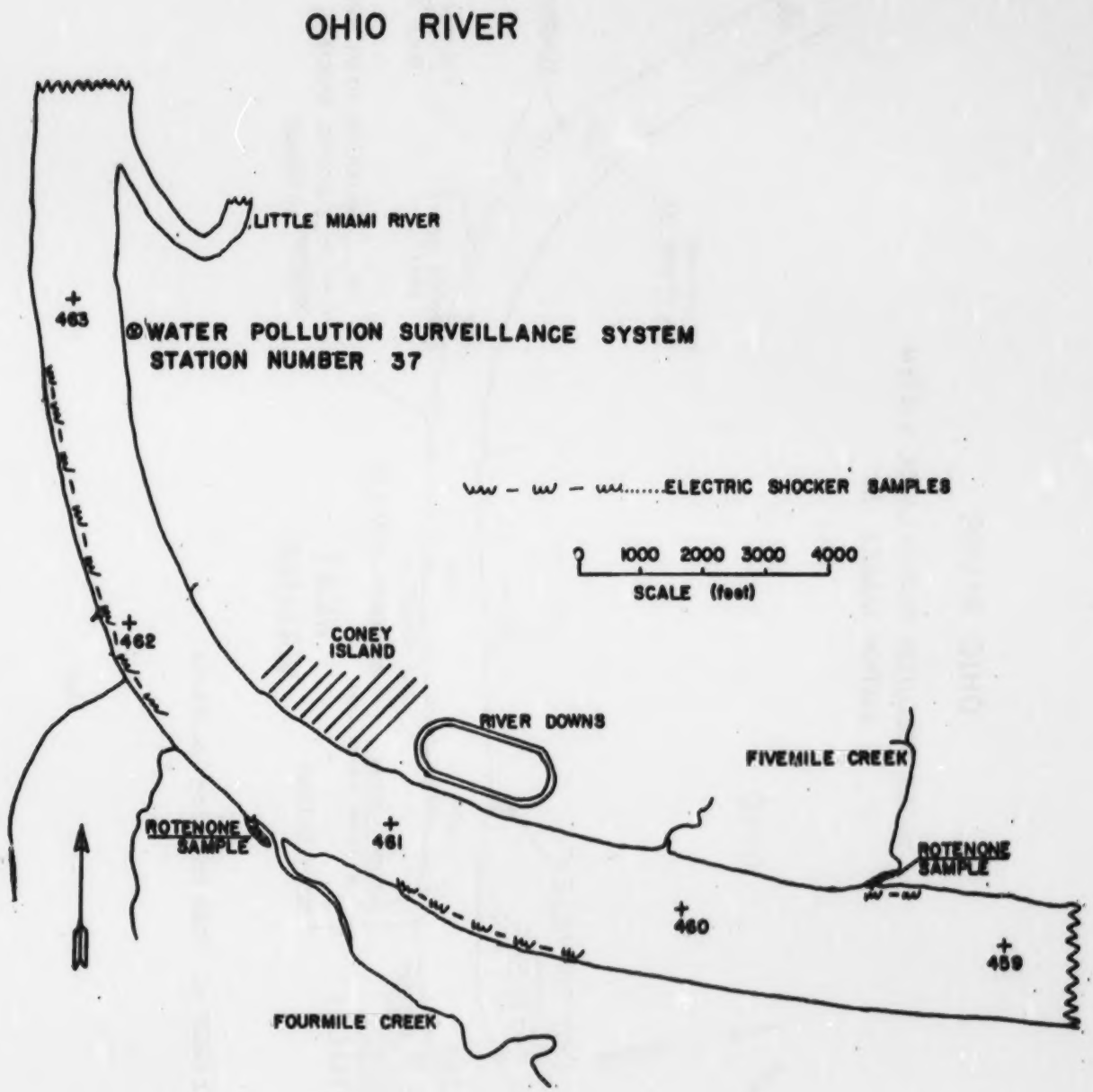


FIGURE 10. Fish sampling locations.

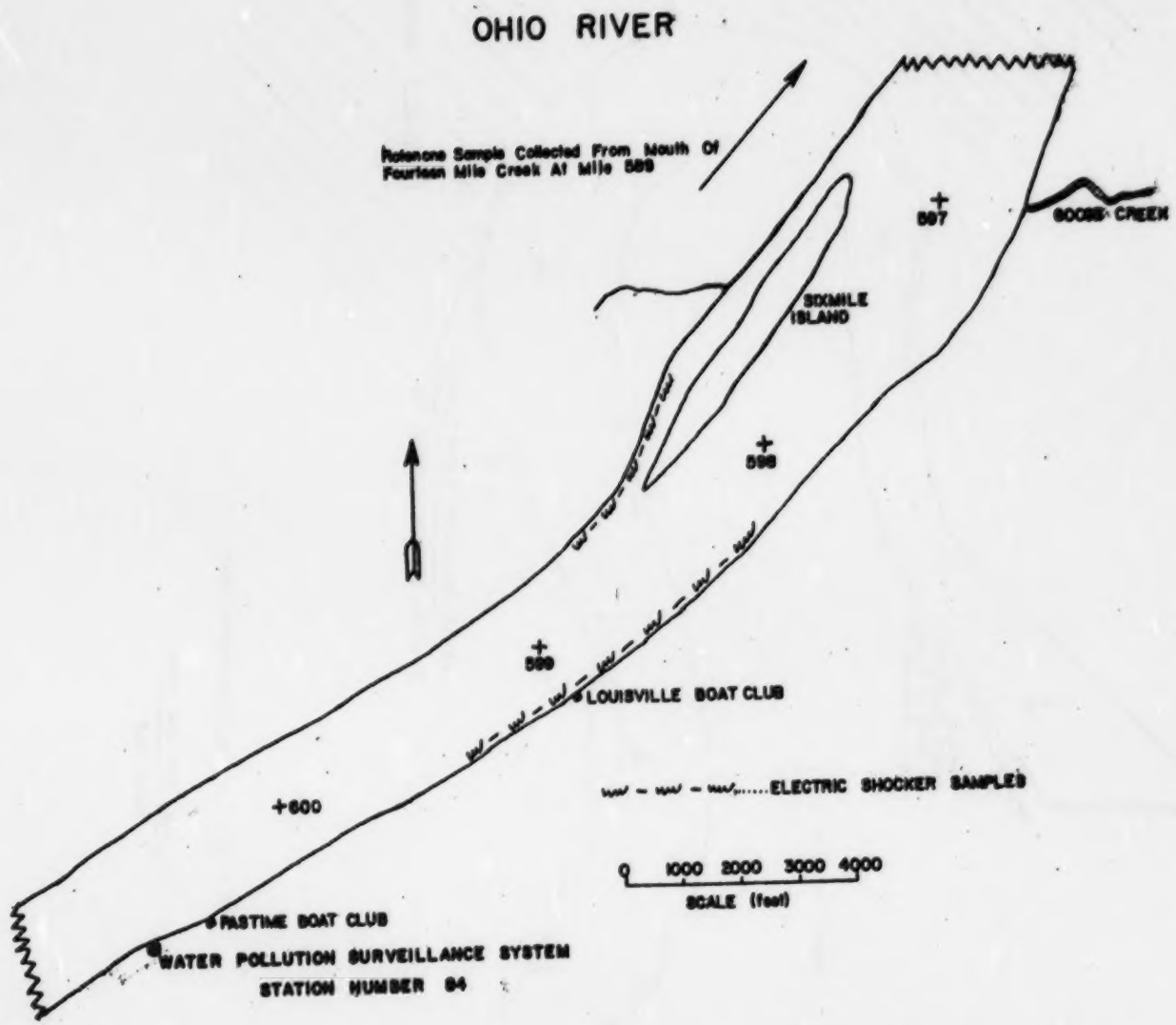


FIGURE 11. Fish sampling locations.

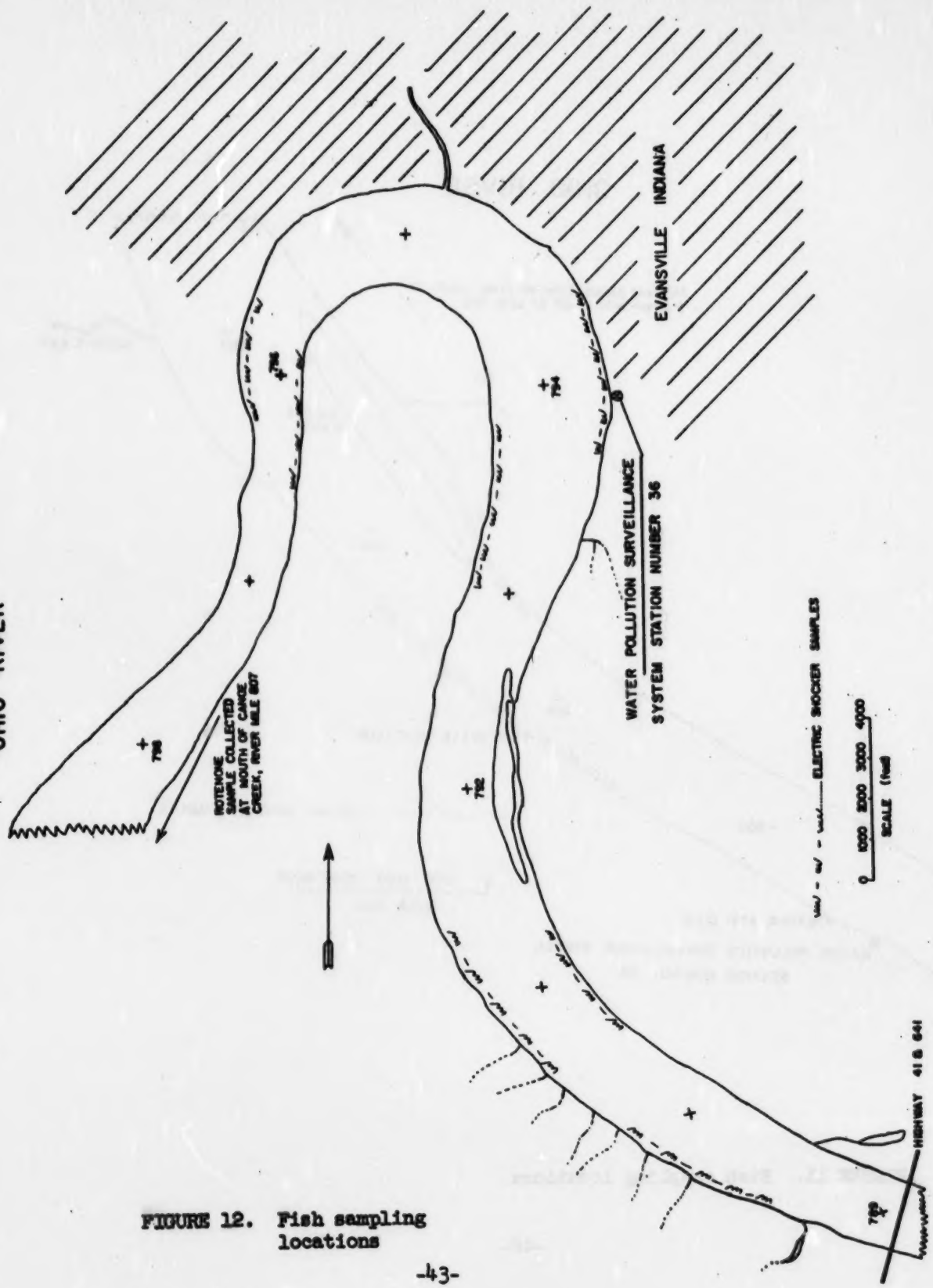


FIGURE 12. Fish sampling locations

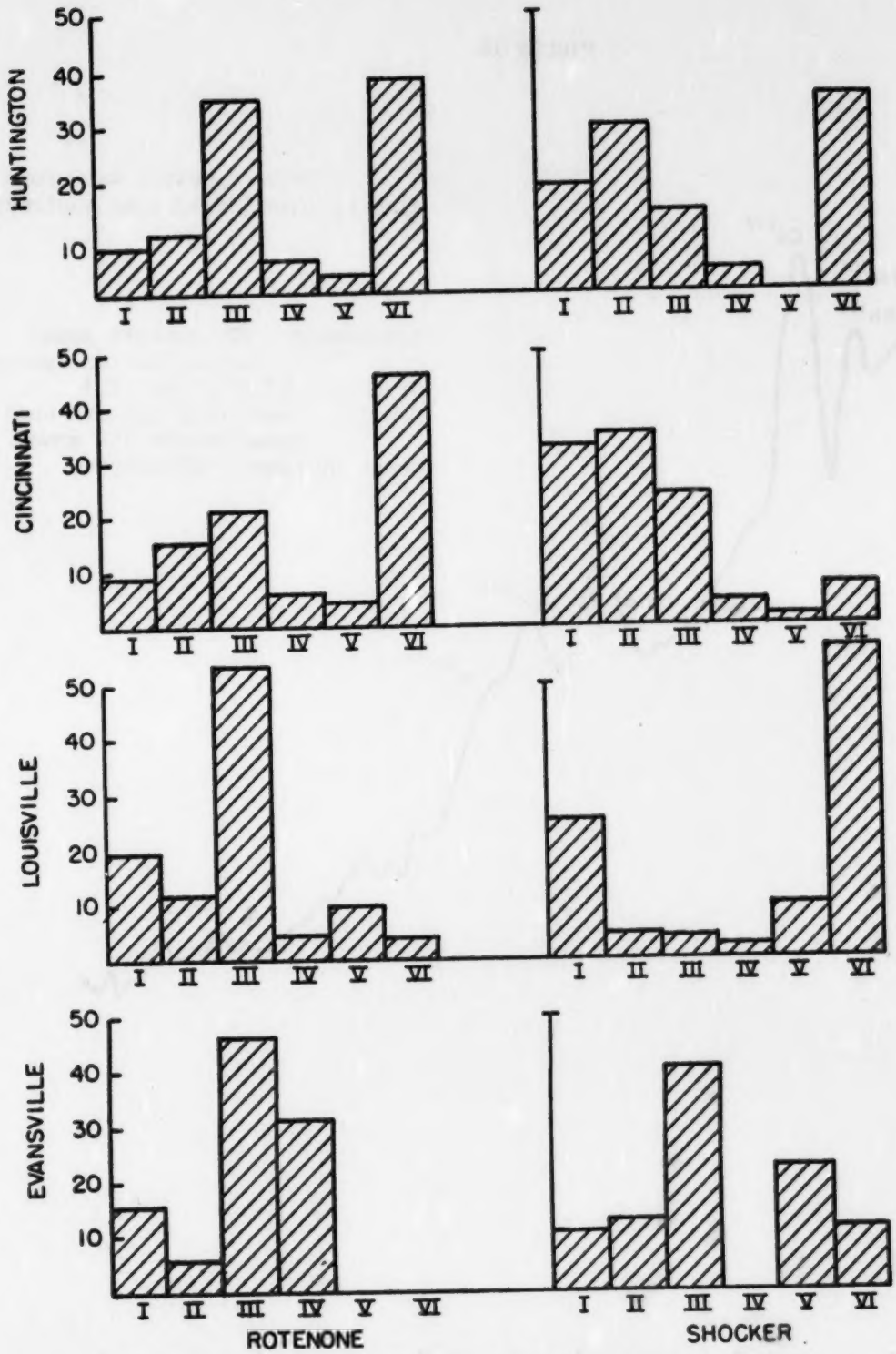
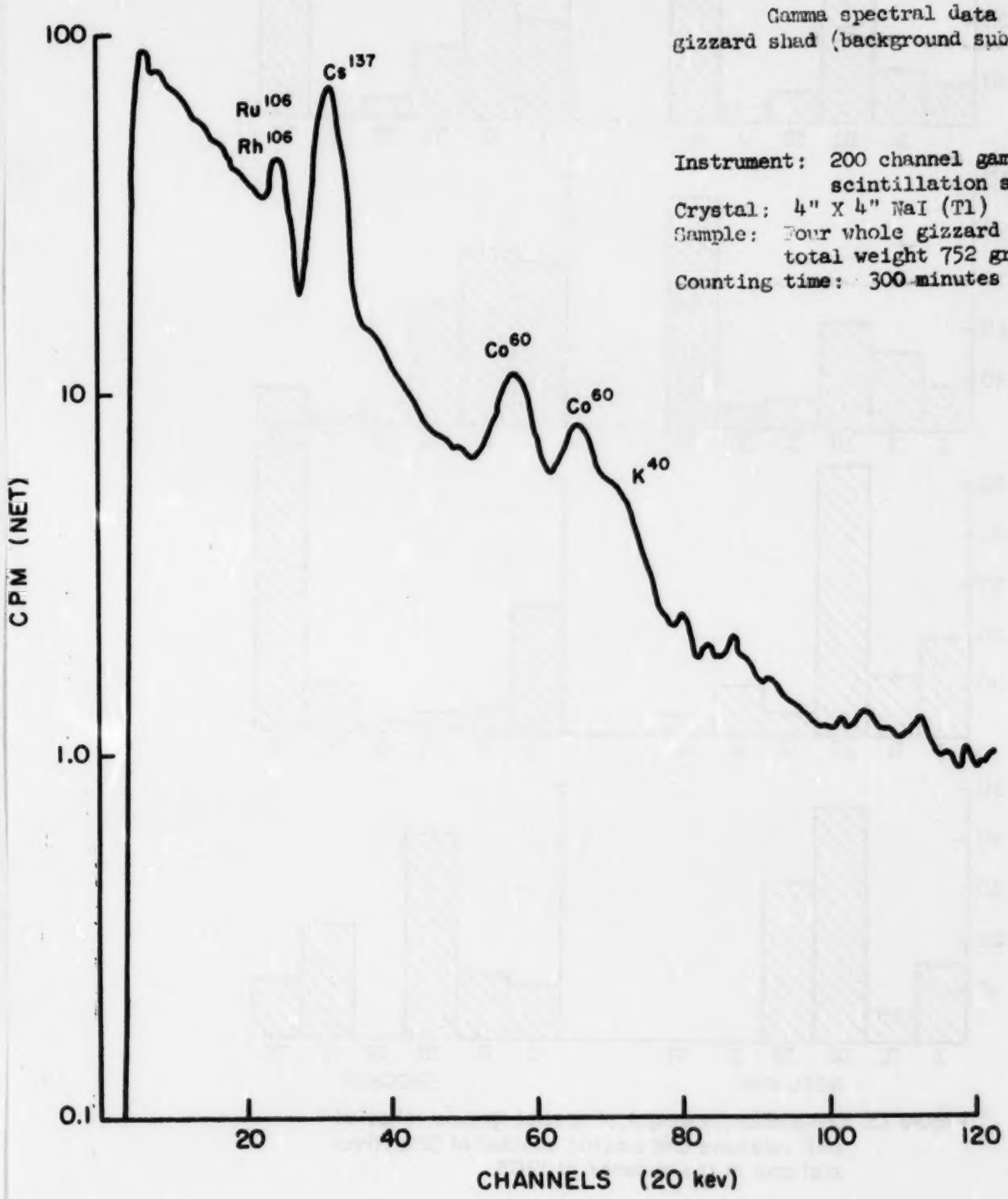


Figure 13. Composition, by weight, of species groups collected with rotenone and electric shocker at Ohio River stations in the summer of 1963.

FIGURE 14

Gamma spectral data for gizzard shad (background subtracted).

Instrument: 200 channel gamma scintillation spectrometer
Crystal: 4" X 4" NaI (Tl)
Sample: Four whole gizzard shad - total weight 752 grams.
Counting time: 300 minutes



APPENDIX III

TABLES

Table 1

Catch Per Hour of Fish Taken with Electric Shocker
From the Ohio River at Louisville, Kentucky
During Hours of Daylight and Darkness
on October 10, 1963

Species	Catch Per Hour (Number of Fish)	
	Daylight	Darkness
Largemouth bass	4	12
Spotted bass	4	5
Smallmouth bass		1
White bass		5
Skipjack	40	16
Bluegill	2	3
Longear sunfish	6	8
Rock bass		2
Emerald shiner	988	67
Spotfin shiner	4	
River shiner	22	2
Silver chub	1	28
Gizzard shad	46	1
Freshwater drum		95
River carpsucker	2	1
Spotted sucker	6	2
Carp		5
Smallmouth buffalo		6
Channel catfish		37

Table 2

Species composition of fish collected
with rotenone and electric shocker
from the Clinch River
in the vicinity of Clinton, Tennessee

		COLLECTING METHOD							
Sampling Date(s)		Rotenone July 29, 1963						Electric Shocker July 25, 1963	
Total No. of fish		8808						655	
Total Wt. of fish (lbs)		67.2							
		Percent of Total		Length Range (inches) Number of fish				Percent of Total	
Group	Species Collected	#	Wt.	0-4	5-8	9-12	over 12	#	Wt.
I	Largemouth bass	<0.1	<0.1	2					
	Smallmouth bass							0.2	
	White crappie	0.1	0.3	6				0.9	
	Banded sculpin	<0.1	0.1	2				2.4	
		0.1	0.4					3.5	
II	Rainbow trout	0.1	0.2	6				0.2	
	Emerald shiner	0.2	0.4	16				2.4	
	Common shiner	<0.1	<0.1	4				4.9	
	Whitetail shiner	<0.1	<0.1	1					
	Spotfin shiner	0.1	<0.1	9				2.0	
	Bluntnose minnow	<0.1	<0.1	2				0.3	
	Flathead minnow	<0.1	<0.1	2					
	Hogsucker	<0.1	1.7	1		2		0.3	
	Bluegill	<0.1	0.2		1			0.3	
	Rock bass	<0.1	0.4		2			0.2	
	Logperch	0.2	0.3	19				1.2	
		0.6	3.2					11.8	

Table 2

(continued)

Group	Species Collected	Percent of Total #	Percent of Total Wt.	Length Range (inches) Number of Fish 0-4	5-8	9-12	over 12	Percent of Total #	Percent of Total Wt.
III	Gizzard shad	99.0	90.1	8668		3	2	79.3	
	Stoneroller	0.1	0.1	12				4.4	
		99.1	90.2					83.7	
IV	Ohio redhorse	0.1	1.9				1		
	Black redhorse	0.2	2.3	3	17			0.6	
		0.2	4.2					0.6	
V	Plains carpsucker	0.1	0.2	4					
	White sucker	0.1	0.8	3		2			
		0.1	1.0						
VI	Carp	0.1	0.2	1	1				
	Goldfish	0.1	0.2	1	1				
	Smallmouth buffalo	0.1	0.2	4					
	Channel catfish	0.1	0.4	13				0.2	
	Flathead catfish							0.2	
		0.1	1.0					0.4	

Table 3

Check List of Species Collected from Clinch River
in the Vicinity of Clinton, Tennessee
By Various Agencies
Between 1953 and 1963

Species	Year of Collection 1953[1]	1955[2]	1960,61,62[3]	1963[4]
Largemouth bass				x
Smallmouth bass		x	x	x
Spotted bass		x	x	
White crappie			x	x
White bass	x			
Walleye				
Sauger	x		x	
Skipjack herring	x		x	
Banded sculpin	x	x	x	x
Longnose gar			x	
Rainbow trout	x	x	x	x
Bluegill			x	x
Warmouth		x		
Rock bass			x	x
Hogsucker		x	x	x
Logperch	x	x	x	x
Mooneye			x	
Emerald shiner				x
Spotfin shiner				x
Common shiner				x
Whitetail shiner				x
Bluntnose minnow				x
Flathead minnow				x
Gizzard shad	x	x	x	x
Threadfin shad	x	x	x	
Stoneroller			x	x
Ohio redhorse	x		x	x
Black redhorse	x		x	x
River redhorse	x		x	
Golden redhorse			x	
Silver redhorse			x	
Freshwater drum	x	x	x	
River carpsucker			x	
Plains carpsucker				x
Quillback carpsucker			x	
Highfin carpsucker	x			
White sucker				x
Spotted sucker		x		
Hornyhead chub			x	

Table 3 (Continued)

Species	Year of Collection 1953[1]	1955[2]	1960,61,62[3]	1963[4]
Carp	x		x	x
Goldfish				x
Smallmouth buffalo	x		x	x
Channel catfish		x	x	x
Flathead catfish				x
Total number of species	15	12	28	26

[1] Rotenone sample approximately 1.5 miles below Norris Dam collected on May 12, 1953 by Tennessee Department of Game and Fish and TVA biologists.

[2] Rotenone sample approximately 2.5 miles below Norris Dam collected on June 2, 1955 by Tennessee Department of Game and Fish and TVA biologists.

[3] Gill net samples collected during June and October 1961, 1962 and rotenone sample collected November 1, 1962 in the vicinity of Highway 61 bridge by TVA biologists.

[4] Rotenone and electric shocker samples collected July 24 and 25 by WPSS personnel and TVA biologists.

Table 4

Species composition of fish collected
with rotenone and electric shocker
from the Clinch River
in the vicinity of Kingston, Tennessee

COLLECTING METHOD

Sampling Date(s)		Rotenone July 30, 1963						Electric Shocker July 31 & August 1, 1963	
Total No. of fish		498						2114	
Total Wt. of fish (lbs)		126.9						93.6	
		Percent of Total		Length Range (inches) Number of Fish				catch-per-hour = 24.6 lbs Percent of Total	
Group	Species Collected	#	Wt.	0-4	5-8	9-12	over 12	#	Wt.
I	Longnose gar	0.4	<0.1		2				
	Skipjack	0.2	0.5				1		
	White bass	0.4	<0.1	2				0.2	1.2
	Largemouth bass	2.0	2.6	3	3	2	2	2.4	12.1
	Spotted bass							0.6	5.0
	Smallmouth bass							<0.1	0.2
	White crappie	4.0	2.3	14		6		2.8	9.1
	Sauger	0.4	0.1		2			0.1	0.3
	Walleye							0.1	<0.1
		7.4	5.5					6.2	27.9
II	Emerald shiner	7.0	0.1	35				1.8	0.2
	Common shiner	10.6	0.1	53					
	Spotfin shiner	1.0	<0.1	5				0.9	C.1
	Bullhead minnow	7.6	0.1	38				0.8	<0.1
	Hogsucker							<0.1	0.1
	Rock bass							<0.1	<0.1
	Warmouth	0.2	0.1	1				0.2	0.5
	Bluegill	6.0	2.0	20	10			3.0	4.2
	Redear sunfish							0.7	0.9
	Logperch							0.7	0.1
	Brook silversides							0.2	<0.1
		32.4	2.4					8.3	6.1

Table 4
(continued)

Group	Species Collected	Percent of Total #	Percent of Total Wt.	Length Range (inches) Number of Fish 0-4	5-8	9-12	over 12	Percent of Total #	Percent of Total Wt.
III	Gizzard shad	17.4	4.0	75		10		40.4	14.6
	Threadfin shad	7.8	0.1	39				42.8	3.2
		25.2	4.1					83.2	17.8
IV	Black redhorse	7.8	10.4	6	19	9	5	[illegible]	[illegible]
	Golden redhorse	3.8	0.8	19				0.8	2.0
	Freshwater drum	4.8	2.7	3	16	5		0.5	0.6
		16.4	13.9					1.3	2.6
V	River carpsucker	1.2	16.6				6		
	Quillback carpsucker	11.0	0.2	55					
	Plains carpsucker							0.2	4.2
		12.2	16.8					0.2	4.2
VI	Carp	2.6	22.8				13	0.5	21.9
	Smallmouth buffalo	3.8	34.5				19	0.1	4.9
	Black buffalo							0.2	14.6
		6.4	57.3					0.8	41.4

Table 5

Check List of Species Collected from Clinch River
In the Vicinity of Kingston, Tennessee
by Various Agencies
Between 1960 and 1963

Species	1960[1]	1960,61,62[2]	1963[3]
Longnose gar	x	x	x
Skipjack	x	x	x
White bass	x	x	x
Largemouth bass	x	x	x
Spotted bass	x	x	x
Smallmouth bass	x		x
White crappie	x	x	x
Black crappie	x		
Sauger	x	x	x
Walleye	x	x	x
Mooneye	x	x	
Emerald shiner			x
Common shiner			x
Spotfin shiner			x
Bullhead minnow			x
Hogsucker		x	x
Rock bass	x		x
Warmouth			x
Bluegill	x	x	x
Redear sunfish			x
Longear sunfish	x	x	
Redbreast sunfish		x	
Logperch		x	x
Brook silversides			x
Gizzard shad	x	x	x
Threadfin shad		x	x
Black redhorse	x	x	x
Golden redhorse	x	x	x
River redhorse	x	x	
Shorthead redhorse		x	
Freshwater drum	x	x	x
River carpsucker			x
Quillback carpsucker			x
Plains carpsucker			x
Carp	x	x	x
Smallmouth buffalo	x	x	x
Bigmouth buffalo	x		
Black buffalo	x		x
Yellow bullhead	x		

Table 5 (continued)

Species	1960[1]	1960,61,62[2]	1963[3]
Channel catfish	x	x	
Blue catfish	x	x	
Flathead catfish	x	x	
Total number of species	27	26	31

[1] Hoop net samples in vicinity of White Oak Creek (mile 20.8) collected July 6-September 21, 1960 and April 12-July 13, 1961 by biologists of TVA, Tennessee Department of Game and Fish.

[2] Rotenone, hoop net and gill net samples from vicinity of mile 4.9 collected during 1960, 1961 and 1962 by TVA biologists.

[3] Rotenone and electric shocker samples collected July 30, 31, and August 1, 1963 in vicinity of Gallahers Bridge (mile 14.5) by WPSS personnel and TVA biologists.

Table 6

Species composition of fish collected
with rotenone and electric shocker
from the Tennessee River
in the vicinity of Lenoir City, Tennessee

		COLLECTING METHOD							
Sampling Date(s)		Rotenone July 23, 1963						Electric Shocker July 23 and 24, 1963	
Total No. of fish		218						161	
Total Wt. of fish (lbs)		34.8						27.1	
				Length Range (inches) Number of Fish				catch-per-hour=9.7 lbs	
Group	Species Collected	Percent of Total #	Percent of Total Wt.	0-4	5-8	9-12	over 12	Percent of Total #	Percent of Total Wt.
I	Longnose gar							0.6	4.9
	Skipjack	1.9	5.4			2	2		
	White bass							3.7	3.8
	Smallmouth bass							10.6	7.3
	Spotted bass							6.2	12.1
	White crappie	3.8	0.1	8				1.9	0.1
	Sauger	15.5	7.7	24	6	3	1		
		21.2	13.2					23.0	28.2
II	Mooneye	0.9	2.1			2			
	Silver chub	5.5	1.2	12					
	Emerald shiner	4.6	0.6	10				0.6	0.1
	Spotfin shiner	8.7	0.5	19				3.7	0.2
	Bullhead minnow	2.8	0.1	6					
	Redbreast sunfish							16.2	14.1
	Bluegill	1.9	0.8	3	1			31.1	17.8
	Logperch	0.9	0.1	1	1				
		25.3	5.4					51.6	32.2

Table 6
(continued)

Group	Species Collected	Percent of Total #	Percent of Total Wt.	Length Range (inches) Number of Fish 0-4	5-8	9-12	over 12	Percent of Total #	Percent of Total Wt.
III	Gizzard shad	6.9	16.9			15		6.8	14.1
	Threadfin shad	32.3	1.0	71				16.8	0.5
		39.2	17.9					23.6	14.6
IV	Golden redhorse	2.8	14.7		2	1	3		
	Freshwater drum	10.1	20.4		17	4	1	0.6	8.3
		12.9	35.1					0.6	8.3
V	Carp	1.4	28.4				3	0.6	9.1
	Smallmouth buffalo							0.6	7.6
		1.4	28.4					1.2	16.7

Table 7

Check List of Species Collected from Tennessee River
In the Vicinity of Lenoir City, Tennessee
By Various Agencies
From 1957 through 1963

Species	Year of Collection 1957,58,59,60[1]	1963[2]
Longnose gar	x	x
Skipjack	x	x
White bass	x	x
Spotted bass	x	x
Largemouth bass	x	
Smallmouth bass	x	x
White crappie	x	x
Black crappie	x	
Sauger	x	x
Mooneye	x	x
Silver chub		x
Emerald shiner		x
Spotfin shiner		x
Bullhead minnow		x
Hogsucker	x	
Redbreast sunfish	x	x
Bluegill	x	x
Warmouth	x	
Logperch		x
Gizzard shad	x	x
Threadfin shad	x	x
Black redhorse	x	x
Golden redhorse	x	x
Shorthead redhorse	x	
Freshwater drum	x	x
Unidentified carpsuckers	x	x
Carp	x	x
Black buffalo	x	
Smallmouth buffalo	x	x
Blue catfish	x	
Channel catfish	x	
Flathead catfish	x	x

[1] Rotenone samples in vicinity of mile 560.5 collected during late August and early September of 1957, 1958, 1959 and 1960 by TVA biologists.

[2] Rotenone, electric shocker and trammel net samples from vicinity of Lenoir City (mile 601) collected July 23 and 24, 1963 by WPSS personnel and biologists of the Tennessee Department of Game and Fish.

Table 8

Species composition of fish collected
with rotenone and electric shocker
from the Tennessee River
in the vicinity of Chattanooga, Tennessee

		COLLECTING METHOD							
Sampling Date(s)		Rotenone July 18, 1963						Electric Shocker July 17, 1963	
Total No. of fish		637						563	
Total Wt. of fish (lbs)		159.6						132.0	
		Percent of Total		Length Range (inches) Number of Fish				catch-per-hour=34.7 lbs. Percent of Total	
Group	Species Collected	#	Wt.	0-4	5-8	9-12	over 12	#	Wt.
I	Longnose gar							0.5	1.3
	Shortnose gar							0.5	3.0
	Skipjack	2.7	1.1	1	13	3		0.2	-
	White bass	7.4	3.2	32	10	4	1	0.4	0.3
	Spotted bass							0.9	0.4
	Largemouth bass	2.5	1.0	3	13			4.4	9.1
	White crappie	0.3	0.2		2			0.2	0.2
	Sauger	0.2	0.2			1			
		13.1	5.7					7.1	14.3
II	Mooneye	0.3	0.7			2		0.5	1.3
	Silver chub	0.9	0.2		6				
	Golden shiner	0.2	0.1		1				
	Emerald shiner	7.5	0.3	48				20.4	0.9
	Spotfin shiner							2.0	0.1
	Mimic shiner	2.2	-	14					
	Undetermined minnow	0.2	-		1				
	Green sunfish	0.2	-	1				0.7	0.1
	Pumpkinseed							1.1	0.8
	Bluegill	14.7	3.4	70	25			45.9	12.5
	Longear sunfish	1.2	0.4	3	5			3.2	0.8
	Redear sunfish	2.1	1.3	2	10	1		2.5	1.5
	Hybrid sunfish	0.3	0.1		2			1.2	0.6
	Logperch	1.6	0.1	10				0.7	-
	Brook silversides	0.2	-	1					
		31.6	6.6					78.2	18.6

Table 8
(continued)

Group	Species Collected	Percent of Total #	Percent of Total Wt.	Length Range (inches) Number of Fish 0-4	5-8	9-12	over 12	Percent of Total #	Percent of Total Wt.
III	Gizzard shad	37.5	45.2		32	206	2	11.7	13.0
	Threadfin shad	1.6	0.1	10					
		39.1	45.3					11.7	13.0
IV	Black redhorse	0.2	0.8				1		
	Golden redhorse	0.5	2.4		1		2		
	Freshwater drum	5.0	2.2	9	21	2			
		5.7	5.4						
V	River carpsucker	0.5	3.6				3		
	Plains carpsucker	0.2	1.4				1		
	White suckucker	0.5	0.1		3				
	Spotted sucker	3.3	15.2		2	4	15	0.9	5.8
		4.5	20.3					0.9	5.8
VI	Carp	0.5	3.2			2	1	1.4	40.0
	Smallmouth buffalo	0.6	6.1		1		3	0.7	8.3
	Channel catfish	4.7	7.1	1	17	3	9		
	Flathead catfish	0.2	0.3			1			
		6.0	16.7					2.1	48.3

Table 9

Species composition of fish collected
with rotenone and electric shocker
from the Tennessee River
in the vicinity of Bridgeport, Alabama

		COLLECTING METHOD							
Sampling Date(s)		Rotenone June 12 and 13, 1963						Electric Shocker June 12, 1963	
Total No. of fish		739						23	
Total Wt. of fish (lbs)		115.0						48.5	
		Percent of Total		Length Range (inches) Number of Fish				catch-per-hour=13.0 lbs Percent of Total	
Group	Species Collected	#	Wt.	0-4	5-8	9-12	over 12	#	Wt.
I	Spotted gar	0.3	1.2						
	Longnose gar							8.7	16.7
	Shortnose gar	0.3	2.8					4.3	3.0
	Skipjack	0.1	<0.1					13.0	5.8
	White bass	0.3	0.2					8.7	3.6
	Largemouth bass	2.0	13.4						
	Spotted bass	2.0	1.5						
	White crappie	1.6	2.2					4.3	0.8
	Sauger	0.4	0.6						
		7.0	21.9					39.0	29.9
II	Emerald shiner	38.5	2.0						
	Ribbon shiner	0.3	<0.1						
	Spotfin shiner } Steelcolor shiner }	12.0	0.4						
	Flathead minnow	0.1	<0.1						
	Longear sunfish	0.7	0.2						
	Redear sunfish	0.7	0.6						
	Bluegill	10.8	3.4						
	Warmouth	0.3	0.5						
	Logperch	0.9	0.1						
	Brook silversides	0.1	<0.1						
		64.4	7.2						

Table 9

(continued)

Group	Species Collected	Percent of Total #	Percent of Total Wt.	Length Range (inches) Number of Fish 0-4	5-8	9-12	over 12	Percent of Total #	Percent of Total Wt.
III	Gizzard shad	25.7	39.3						
		25.7	39.3						
IV	Freshwater drum	0.7	2.6						
		0.7	2.6						
V	River carpsucker	0.4	5.9					26.3	31.6
	Spotted sucker	0.1	0.7						
		0.5	6.6					26.3	31.6
VI	Carp	0.9	12.9						
	Bigmouth buffalo							4.3	10.8
	Smallmouth buffalo	0.8	9.5					17.4	17.9
	Channel catfish							8.7	7.4
	Flathead catfish							4.3	2.4
		1.7	22.4					34.7	38.5

Table 10

Species composition of fish collected
with rotenone and electric shocker
from the Ohio River
in the vicinity of Huntington, West Virginia

COLLECTING METHOD

Sampling Date(s)		Rotenone September 10, 1963						Electric Shocker September 11, 1963					
Total No. of fish		1312						1293					
Total Wt. of fish (lbs)		53.4						20.4					
		Percent of total		Length Range (inches) Number of Fish				Percent of total		Length Range (inches) Number of Fish			
Group	Species Collected	#	Wt.	0-4	5-8	9-12	over 12	#	Wt.	0-4	5-8	9-12	over 12
I	Largemouth bass	0.4	2.5		3	2		0.3	5.4		3	1	
	Spotted bass	0.1	0.1		1			0.2	5.2		2	1	
	Smallmouth bass	0.1	0.4		1			0.2	1.1		3		
	Black crappie	1.7	4.2	13	8	1		0.2	3.2		1	1	
	Rock bass							0.3	3.3		4		
	Skipjack	0.3	0.5	1	3			0.1	0.3		1		
		2.6	7.7					1.3	18.5				
II	Bluegill	6.7	2.8	83	5			1.8	5.3	19	4		
	Longear sunfish	0.3	0.4	3	1			6.3	10.6	77	5		
	Redear sunfish	5.0	1.6	66				0.2	0.3	3			
	Green sunfish	0.2	<0.1	3				8.3	16.2				
	Orangespot sunfish	3.4	0.8	45									
	Warmouth	1.1	0.2	15									
	Emerald shiner	4.7	0.4	62				53.8	10.8	699			
	Spotfin shiner	4.3	0.2	57				3.4	0.3	44			
	Mimic shiner	0.6	<0.1	8				6.6	1.2	85			
	Steelcolor shiner	0.2	<0.1	2				0.1	<0.1	1			
	Common shiner	10.8	2.3	140				0.5	0.7	6			
	Sand shiner	5.4	0.4	71				0.3	0.1	4			
	Golden shiner	0.2	0.1	2									
	River shiner	1.4	0.1	19				0.2	<0.1	3			
	Bluntnose minnow	11.4	0.7	151				1.8	0.4	23			
	Silver chub	0.5	0.1	7									
	Stoneroller	0.2	<0.1	2				C.2	0.2	2			

Table 10
(continued)

Group	Species Collected	Percent of total #	Percent of total Wt.	Length Range (Inches) Number of Fish 0-4	5-8	9-12	over 12	Percent of total #	Percent of total Wt.	Length Range (inches) Number of Fish 0-4	5-8	9-12	over 12
	Brindled madton	0.2	<0.1	2									
	Johnny darter	0.1	<0.1	1									
	Logperch	0.1	<0.1	1									
		56.8	10.1					65.9	13.7				
III	Gizzard shad	19.6	34.9	6	239	14		4.2	14.6		55		
		19.6	34.9					4.2	14.6				
IV	Freshwater drum	0.4	1.2	4		1		2.2	2.3	28			
	Ohio redhorse	0.3	0.8		3	1		0.1	0.1		1		
	Shorthead redhorse	0.1	0.2		1			0.2	1.0		2		
	Golden redhorse	0.3	4.2	1	2		1						
		1.1	6.4					2.5	3.4				
V	Spotted sucker	0.3	2.1		1	2	1						
	White sucker	0.3	0.7		4								
		0.6	2.8										
VI	Channel catfish	11.4	31.0	22	119	4	4	15.8	20.5	185	17	1	1
	Flathead catfish	0.1	<0.1	1				0.2	0.1	2			
	Brown bullhead	0.5	4.8		3	4		0.1	1.9			1	
	Black bullhead	7.1	2.3	90	3								
	Yellow bullhead	0.2	<0.1	2				0.1	2.4			1	
	Goldfish							0.1	2.2			1	
	Carp							0.4	4.9		5		
	Smallmouth buffalo							0.1	1.6			1	
		19.3	38.1					16.8	33.6				

Table 11

Check List of Fish Species Collected From Ohio River
in Vicinity of Huntington, West Virginia
By Various Agencies
During 1957, 1958, 1959 and 1963

Species	1957[1]	1958[1]	1959[1]	1963[2]
Largemouth bass		x		x
Spotted bass				x
Smallmouth bass				x
Black crappie		x		x
White crappie	x	x		
Rock bass		x		x
Ohio muskellunge			x	
Sauger		x		
Walleye		x		
Longnose gar			x	
Ohio lamprey	x			
Skipjack	x	x	x	x
Bluegill	x	x		x
Longear sunfish		x	x	x
Redear sunfish	x		x	x
Green sunfish		x	x	x
Orangespot sunfish				x
Warmouth	x		x	x
Emerald shiner	x			x
Spotfin shiner				x
Mimic shiner				x
Steelcolor shiner	x			x
Common shiner				x
Sand shiner				x
Golden shiner				x
River shiner				x
Bluntnose minnow				x
Silver chub				x
Bullhead minnow	x			
Stoneroller				x
Brindled madtom		x		x
Johnny darter				x
Logperch				x
Gizzard shad	x	x	x	x
Paddlefish			x	

Table 11 (Continued)

Species	Year of Collection 1957[1]	1958[1]	1959[1]	1963[2]
Freshwater drum	x	x	x	x
Ohio redhorse				x
Shorthead redhorse				x
Golden redhorse				x
Spotted sucker		x		x
White sucker				x
River carpsucker	x	x		
Channel catfish	x	x	x	x
Flathead catfish	x	x	x	x
Brown bullhead				x
Black bullhead	x	x		x
Yellow bullhead				x
Goldfish				x
Carp	x	x		x
Smallmouth buffalo	x	x	x	x

[1] Collected at Ohio River Locks 29 and 30 during May 1957, June and August 1958 and June 1959 (Krumholz, Charles and Minckley, 1962).

[2] Collected in vicinity of WPSS Station Number 38 by WPSS personnel in cooperation with biologists of the West Virginia Conservation Commission.

Table 12

Species composition of fish collected
with rotenone and electric shocker
from the Ohio River
in the vicinity of Cincinnati, Ohio

		COLLECTING METHOD											
Sampling Date(s)		Rotenone September 19 and 20, 1963						Electric Shocker October 2, 1963					
Total No. of fish		10745						3294					
Total Wt. of fish (lbs)		179.9						31.6					
		Percent of total		Length Range (inches) Number of Fish				Percent of total		Length Range (inches) Number of Fish			
Group	Species Collected	#	Wt.	0-4	5-8	9-12	Over 12	#	Wt.	0-4	5-8	9-12	Over 12
I	Largemouth bass	0.1	0.4		7			0.3	11.1		4	5	
	Smallmouth bass							0.1	2.9		1	1	
	Spotted bass	<0.1	<0.1	2				0.6	8.2		12	1	
	Black crappie	1.3	4.6	97	38	2		0.2	4.0		5	1	
	White crappie	0.5	2.3	44	11	3							
	Sauger	<0.1	<0.1		1			0.1	2.0			2	
	Skipjack	0.2	0.9		20			0.2	3.6		5	1	
	Longnose gar	<0.1	0.2			1	3						
		2.1	8.4					1.5	31.8				
II	Bluegill	3.9	1.4	417	1			0.1	0.6	2	1		
	Longear sunfish							0.1	0.2	3			
	Orangespot sunfish	0.8	0.7	83									
	Redear sunfish	0.1	0.1	7	2								
	Green sunfish	0.4	0.2	44				0.1	<0.1	1			
	Pumpkinseed							0.1	<0.1	1			
	Warmouth	0.2	1.9	11	15								
	Logperch	<0.1	<0.1	2									
	Troutperch	<0.1	<0.1	2									
	Emerald shiner	64.6	8.9	6931				87.8	31.6	2957			
	Spotfin shiner	5.0	0.8	533				0.2	0.1	12			
	Mimic shiner	4.0	0.2	427				0.8	0.1	35			
	Common shiner	<0.1	<0.1	1									
	River shiner	0.5	<0.1	56				0.3	0.1	15			

Table 12
(continued)

Group	Species Collected	Percent of total #	Percent of total Wt.	Length Range (inches) Number of Fish 0-4	5-8	9-12	Over 12	Percent of total #	Percent of total Wt.	Length Range (inches) Number of Fish 0-4	5-8	9-12	Over 12
	Bluntnose minnow	1.9	0.2	206				<0.1	<0.1	1			
	Bullhead minnow	0.2	<0.1	26									
	Silver chub	2.8	1.5	269	31			0.1	0.1	3			
	Suckermouth minnow	<0.1	<0.1	1				0.1	0.1	2			
	Silverjaw minnow	<0.1	<0.1	2									
	Creek chub	<0.1	<0.1	2									
	Stoneroller	0.1	<0.1	6									
	Hogsucker	<0.1	0.1		1			0.1	0.6	1	1		
	Rainbow darter							0.1	<0.1	3			
		84.5	16.0					89.9	33.5				
III	Gizzard shad	5.6	20.7	17	580			2.3	23.0		105		
		5.6	20.7					2.3	23.0				
IV	Freshwater drum	4.9	4.9	523		4	1	4.1	3.2	74			
	Greater redhorse	<0.1	<0.1	1	1								
	Shorthead redhorse	<0.1	<0.1	2				0.1	0.7		1	1	
	Golden redhorse	0.1	0.8	3			2						
	Ohio redhorse							0.1	0.1		1		
		5.0	5.7					4.3	4.0				
V	Plains carpsucker	<0.1	0.1		1								
	Quillback carpsucker	<0.1	0.2	1	2			0.1	1.1			1	
	River carpsucker	0.1	1.1	1	8		1						
	White sucker	0.1	0.3	5		1							
	Spotted sucker	0.2	2.8	9	8	2	2						
		0.4	4.5					0.1	1.1				
VI	Carp	0.8	19.9	58	17	8	6	0.1	3.4			1	
	Channel catfish	1.2	23.0	59	33	18	22	1.8	3.2	30	4		
	Flathead catfish	0.1	0.1	7	2								
	Brown bullhead	<0.1	<0.1	2									
	Black bullhead	0.2	0.5	13	7	1							
	Smallmouth buffalo	0.1	1.2	4	3	4							
		2.4	44.7					1.9	6.6				

Table 13

Check List of Fish Species Collected from Ohio River
In vicinity of Cincinnati, Ohio
by Various Agencies
During 1957, 1958, 1959 and 1963

Species	Year of Collection 1957[1]	1958[1]	1959[1]	1963[2]
Largemouth bass				x
Smallmouth bass				x
Spotted bass				x
Black crappie	x	x		x
White crappie	x	x	x	x
Sauger		x		x
White bass	x	x		
Skipjack	x	x	x	x
Goldeye		x	x	
Bowfin	x			
Longnose gar				x
Bluegill	x	x		x
Longear sunfish		x	x	x
Orangespot sunfish				x
Redear sunfish				
Green sunfish		x		x
Pumpkinseed				x
Warmouth		x		x
Logperch				x
Troutperch				x
Emerald shiner	x			x
Spotfin shiner				x
Mimic shiner	x			x
Common shiner				x
River shiner	x			x
Bluntnose minnow				x
Bullhead minnow				x
Silver chub	x			x
Suckermouth minnow				x
Silverjaw minnow				x
Creek chub				x
Stoneroller				x
Hogsucker				x
Rainbow darter				x
Gizzard shad	x	x	x	x

Table 13 (Continued)

Species	Year of Collection 1957[1]	1958[1]	1959[1]	1963[2]
Freshwater drum	x	x	x	x
Greater redhorse				x
Shorthead redhorse				x
Golden redhorse				x
Ohio redhorse				x
Miscellaneous redhorse			x	
Plains carpsucker				x
Quillback carpsucker				x
River carpsucker	x	x		x
White sucker				x
Spotted sucker				x
Miscellaneous carpsucker		x		
Carp	x	x	x	x
Channel catfish	x	x	x	x
Blue catfish	x	x	x	
Flathead catfish	x	x	x	x
Brown bullhead				x
Black bullhead	x	x		x
Smallmouth buffalo	x			x
Bigmouth buffalo	x			

[1] Collected at Locks 36, 37 and 38 during May 1957, June and July 1958 and June, July and August 1959 (Krumholz, Charles and Minckley, 1962).

[2] Collected in vicinity of WPSS Station Number 37 by WPSS personnel in cooperation with biologists of the Kentucky Department of Fish and Wildlife Resources.

Table 14

Species composition of fish collected
with rotenone and electric shocker
from the Ohio River
in the vicinity of Louisville, Kentucky

		COLLECTING METHOD											
Sampling Date(s)		Rotenone August 22, 1963						Electric Shocker October 10, 1963					
Total No. of fish		1572						858					
Total Wt. of fish (lbs)		39.4						69.4					
		Percent of total		Length Range (inches) Number of Fish				Percent of total		Length Range (inches) Number of Fish			
Group	Species Collected	#	Wt.	0-4	5-8	9-12	Over 12	#	Wt.	0-4	5-8	9-12	Over 12
I	Skipjack	1.8	3.1	14	15			4.2	4.3		36		
	Goldeye	0.1	3.7			1	1						
	White bass	0.3	1.4	1	3	1		0.6	1.0		5		
	Smallmouth bass							0.1	0.4		1		
	Spotted bass	3.2	8.5	23	27	1		0.8	2.8		5	2	
	Largemouth bass	0.4	2.6	4	2	1		1.6	16.6		4	6	4
	White crappie	0.2	0.1	4									
		6.0	19.4					7.3	25.1				
II	Silver chub	5.7	2.4	89				3.4	0.3	29			
	Emerald shiner	43.6	5.2	683				65.4	1.9	561			
	River shiner	0.1	<0.1	2				1.5	0.1	13			
	Spotfin shiner	0.4	0.2	6				0.2	<0.1	2			
	Mimic shiner	0.5	<0.1	8									
	Tadpole madtom	0.2	0.1	3									
	Rock bass							0.1	0.3		1		
	Green sunfish	0.1	0.1	1									
	Bluegill	1.2	1.2	16	3			0.5	0.4	2	2		
	Longear sunfish	1.8	2.6	28	1			1.3	1.0	6	5		
	Logperch	0.1	<0.1	1									
		53.7	11.8					72.4	4.0				

Table 14
(Continued)

Group	Species Collected	Percent of total #	Percent of total Wt.	Length Range (inches) Number of Fish 0-4	5-8	9-12	Over 12	Percent of total #	Percent of total Wt.	Length Range (inches) Number of Fish 0-4	5-8	9-12	Over 12
III	Gizzard shad	29.4	53.3	242	217	3		2.8	3.6		24		
		29.4	53.3					2.8	3.6				
IV	Freshwater drum	8.5	3.8	123	7	3		11.1	1.9	93	2		
		8.5	3.8					11.1	1.9				
V	River carpsucker	0.2	0.4	1	2			0.2	5.0				2
	Spotted sucker	1.3	8.2	4	13	4		0.6	4.2		3		2
		1.5	8.6					0.8	9.2				
VI	Carp							0.6	26.5				5
	Smallmouth buffalo							0.7	5.8			5	1
	Yellow bullhead	0.1	0.1	1									
	Channel catfish	0.4	2.7	3	1	1	1	4.3	23.9	20	1	4	12
	Flathead catfish	0.4	0.3	6	1								
		0.9	3.1					5.6	56.2				

Table 15

Check List of Fish Species Collected from the Ohio River
In the Vicinity of Louisville, Kentucky
by Various Agencies
During 1957, 1958, 1959 and 1963

Species	Year of Collection 1957[1]	1958[1]	1959[1]	1963[2]
Spotted gar	x			
Longnose gar	x	x		
Skipjack	x	x	x	x
Goldeye		x		x
White bass				x
Smallmouth bass				x
Spotted bass				x
Largemouth bass				x
White crappie	x	x		x
Black crappie	x	x		
Sauger		x		
Walleye		x		
Mooneye		x		
Silver chub	x			x
Emerald shiner	x			x
River shiner				x
Spotfin shiner				x
Mimic shiner	x			x
Tadpole madtom				x
Rock bass				x
Green sunfish				x
Bluegill	x			x
Longear sunfish		x		x
Warmouth		x		
Logperch				x
Gizzard shad	x	x	x	x
Freshwater drum	x	x	x	x
River carpsucker	x	x		x
Spotted sucker				x
Carp		x		x
Smallmouth buffalo	x	x	x	x
Black bullhead	x			
Yellow bullhead				x
Flathead catfish	x	x	x	x
Channel catfish	x	x	x	x
Blue catfish		x	x	
American eel			x	

Table 15 (Continued)

[1] Collected at Lock 43 during July 1957, 1958 and August 1959 by Kentucky Department of Fish and Wildlife biologists.

[2] Collected in vicinity of WPSS Station No. 84, Louisville, Kentucky by WPSS personnel in cooperation with biologists of the Kentucky Department of Fish and Wildlife Resources.

Table 16

Species composition of fish collected with rotenone and electric shocker from the Ohio River in the vicinity of Evansville, Indiana

		COLLECTING METHOD							
		Rotenone						Electric Shocker	
Sampling Date(s)		August 12, 1963						August 13, and 14, 1963	
Total No. of fish		237						1440	
Total Wt. of fish (lbs)		2.7						24.7	
		Percent of Total		Length Range (inches) Number of Fish				Percent of Total	
Group	Species Collected	#	Wt.	0-4	5-8	9-12	Over 12	#	Wt.
I	Skipjack	9.3	16.2					2.5	10.1
	Smallmouth bass							0.1	<0.1
	Spotted bass							0.3	1.9
	Largemouth bass							0.1	0.2
		9.3	16.2					3.6	12.2
II	Emerald shiner	59.1	5.4					74.2	9.0
	River shiner	0.8	0.2					16.4	2.5
	Spotfin shiner	0.4	0.1					0.2	0.1
	Green sunfish							0.4	0.4
	Bluegill	0.4	<0.1					0.1	0.2
	Longear sunfish							0.1	0.4
		60.7	5.7					91.4	12.6
III	Gizzard shad	17.3	44.3					3.8	40.2
	Threadfin shad	6.8	2.0					0.4	0.2
		24.1	46.3					4.2	40.4
IV	Freshwater drum	5.1	31.7					0.1	0.8
		5.1	31.7					0.1	0.8
V	River Carpsucker	0.4	0.1					0.2	18.4
	Quillback							0.1	4.0
		0.4	0.1					0.3	22.4
VI	Channel catfish	0.4	<0.1					0.2	1.3
	Flathead catfish							0.7	9.2
	American eel							0.1	1.1
		0.4	<0.1					1.0	11.6

Table 17

Check List of Fish Species Collected from the Ohio River
In the Vicinity of Evansville, Indiana
By Various Agencies
During 1957, 1958, 1959 and 1963

Species	Year of Collection 1957[1]	1958[1]	1959[1]	1963[2]
Longnose gar	x			
Skipjack	x	x		x
Goldeye	x			
Smallmouth bass				x
Spotted bass				x
Largemouth bass				x
Sauger	x		x	
Mooneye	x	x		
Emerald shiner	x			x
River shiner	x			x
Spotfin shiner	x			x
Silver minnow	x			
Silver chub	x			
Mimic shiner	x			
Bluntnose minnow	x			
Silverstripe shiner	x			
Orange spotted sunfish	x			
Green sunfish				x
Bluegill				x
Longear sunfish		x		x
Pirate perch	x			
Rainbow darter	x			
Paddlefish	x			
Gizzard shad	x	x	x	x
Threadfin shad				x
Freshwater drum	x	x	x	x
River carpsucker	x	x	x	x
Quillback carpsucker	x			x
Carp	x	x	x	
Smallmouth buffalo	x	x	x	
Bigmouth buffalo	x	x	x	
Blue catfish	x	x	x	
Channel catfish	x	x	x	x
Flathead catfish	x	x	x	x
American eel				x

Table 17 (Continued)

[1] Collected at Lock 49 during June 1957, September 1958 and 1959 by Kentucky Department of Fish and Wildlife biologists.

[2] Collected in vicinity of WPSS Station Number 36 at Evansville, Indiana by WPSS personnel in cooperation with biologists of the Kentucky Department of Fish and Wildlife Resources.

Table 18

Species composition of fish collected
with rotenone and electric shocker
from the Cumberland River
in the vicinity of Clarksville, Tennessee

		COLLECTING METHOD							
Sampling Date(s)		Rotenone August 26, 1963						Electric Shocker August 27, 28, 1963	
Total No. of fish		296						342	
Total Wt. of fish (lbs)		122.5						84.6	
		Percent of Total		Length Range (inches) Number of Fish				Percent of Total	
Group	Species Collected	#	Wt.	0-4	5-8	9-12	Over 12	#	Wt.
I	Longnose gar							0.6	0.2
	White bass	0.7	<0.1	2					
	Largemouth bass	0.7	0.6		1		1		
	Spotted bass	0.7	<0.1	2				6.4	4.8
	Smallmouth bass							0.3	0.1
	White crappie	0.3	<0.1		1				
	Black crappie	0.3	<0.1		1				
	Sauger	0.3	0.2		1			0.6	0.5
		3.0	0.8					7.9	5.6
II	Mooneye							1.8	1.9
	Bigeye chub							0.3	<0.1
	Emerald shiner	32.0	0.4	94				27.8	0.5
	Ghost shiner	0.3	<0.1	1					
	Spotfin shiner	3.4	<0.1	10				1.8	<0.1
	Mimic shiner	0.3	<0.1	1					
	Pugnose minnow	0.3	<0.1	1				0.9	<0.1
	Bullhead minnow	3.4	<0.1	10				1.5	<0.1
	Pirate perch	0.7	<0.1	2					
	Rock bass							0.9	0.3
	Green sunfish							0.6	0.1
	Longear sunfish	1.0	0.2		3			10.2	2.8
	Redear sunfish	2.4	0.1	7					
	Bluegill	8.4	1.5	5	8			8.5	2.4
	Greenside darter							0.3	<0.1
		52.2	2.2					54.6	8.0

Table 18
(Continued)

Group	Species Collected	Percent of Total #	Percent of Total Wt.	Length Range (inches) Number of Fish 0-4	5-8	9-12	Over 12	Percent of Total #	Percent of Total Wt.
III	Gizzard shad	25.1	6.6		4	27	2	24.8	22.8
	Threadfin shad	0.3	<0.1		1			0.3	<0.1
		25.4	6.6					25.1	22.8
IV	Shorthead redhorse							0.6	
	River redhorse							0.6	
	Black redhorse							2.0	29.8
	Golden redhorse	0.3	<0.1	1				4.4	
	Ohio redhorse							0.3	
	Freshwater drum	9.8	8.0		2	24	3	1.2	1.9
		10.1	8.0					9.1	31.7
V	River carpsucker	0.3	0.8				1		
	White sucker	0.7	0.9			2			
	Spotted sucker	1.7	1.9	2		2	1	0.6	1.0
		2.7	3.6					0.6	1.0
VI	Carp	5.4	74.1				16	0.9	28.1
	Bigmouth buffalo	0.3	3.8				1		
	Channel catfish	0.3	0.4				1		
	Flathead catfish							0.6	0.7
	Yellow bullhead	0.3	<0.1	1					
	American eel	0.3	0.5				1	1.2	2.1
		6.6	78.8					2.7	30.9